CIVIL ENGINEERING

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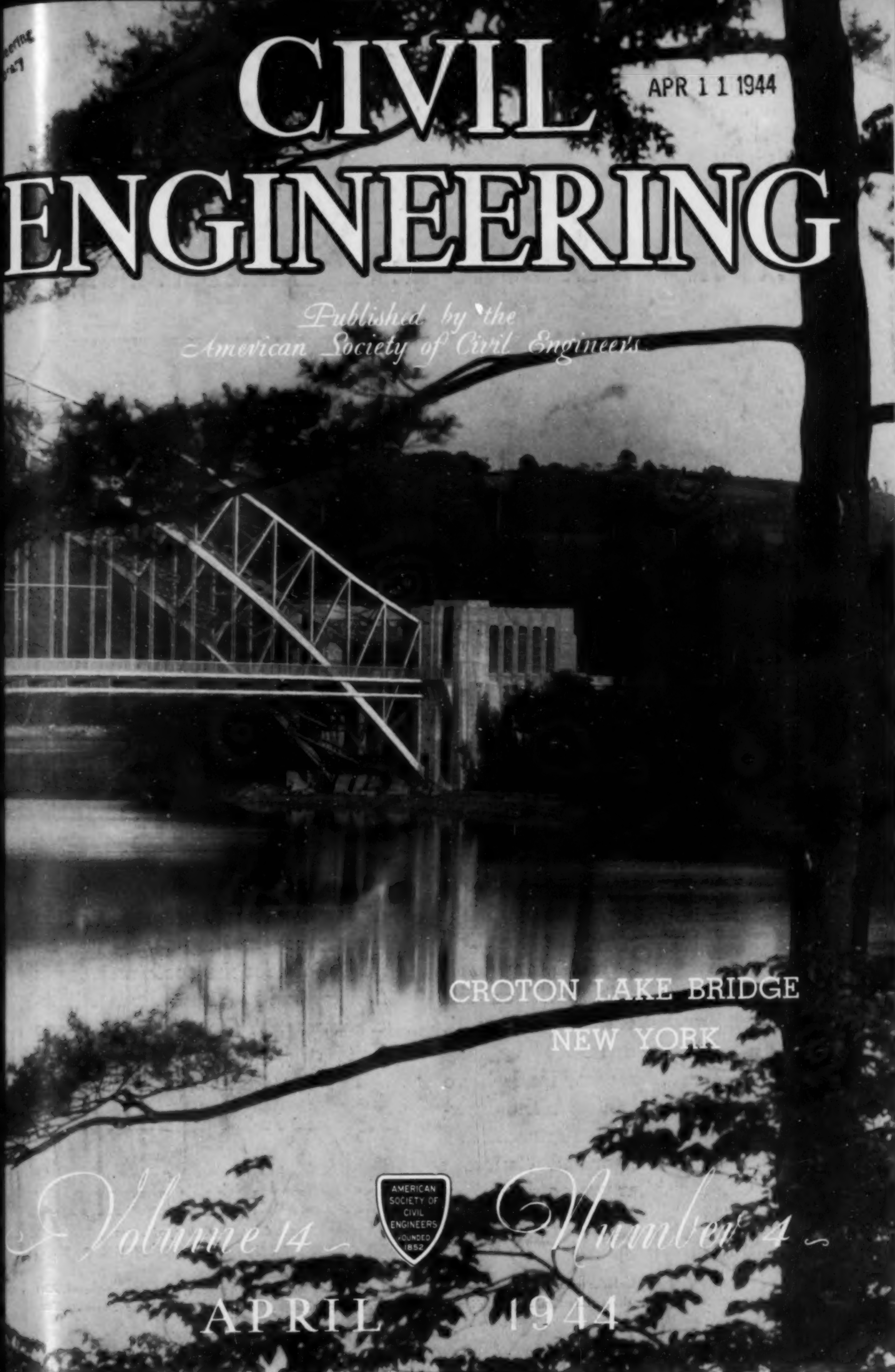

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AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

APRIL 1944

Among Our Writers

FRED W. STIEFEL has supervised the construction of many large projects in and near New York, including 150 million dollars worth of subway work, the Jersey headings of the Holland Tunnel, the longest stretch of subaqueous tunnel under the Harlem and East rivers, 15 miles of aqueduct tunnel for the Board of Water Supply (a 21-million-dollar job) with deep access shafts, and a 2,000-ft shaft and appurtenant work at Fisher Hill, N.Y.

AYMAR EMBURY II received civil engineering and master of science degrees from Princeton, but has practiced architecture ever since—a period of over 40 years. In addition to his private practice he has been architect for the Port of New York Authority, and consultant architect for the Triborough, Whitestone, Rainbow, and other bridges.

PAUL BAUMANN (Swiss Federal Inst. of Tech.) was engaged in military flood-control engineering in the Alps before coming to this country in 1920. He has since specialized in hydraulic engineering, particularly dams. For the past decade he has been connected with construction, maintenance, and operation work of the Los Angeles County Flood Control District.

O. GRAHAM (U. of Montreal, École Polytechnique, '21) had been for many years on the staff of the Quebec Streams Commission when, in 1937, he was appointed assistant chief engineer. In 1940 he became chief engineer of the Commission, a position he recently resigned to join the staff of E.G.M. Cape and Co., contractors of Montreal.

HAL G. SOURS (U. of Akron, '16) served in the Coast Artillery during World War I, as lieutenant. He then went with the Ohio State Highway Dept. (1919–1925), and with Summit County as county engr. (1925–1936). After a period with the Truscon Div., Republic Steel Co., as consulting engr. on highway products, he was appointed chief engr. of the Ohio Dept. of Highways in 1939, and Director of the Dept. in 1940.

GEORGE SPANN (St. John's U., Brooklyn, School of Law; New York U.), civil engineer, has been with the Board of Water Supply of the City of New York for the last 23 years and for the past 3 on the Chief Engineer's staff. Previously he served in various capacities both in the office and on construction work for the Board.

L. G. SUMNER (Sheffield Scientific School of Yale U., '15) after brief experience in railroad work, entered the Connecticut Highway Department in 1916. He has served successively as designer, chief draftsman, and engineer of bridges, in which latter capacity he is in charge of all bridge design and maintenance for the Connecticut State Highway Department.

B. W. BELYEA is president of the Belyea Truck Co., which specializes in the movement of heavy, bulky, and unusual articles. He is also president of Pacific Crane & Rigging, Inc., active in the erection of refinery equipment, structural and bridge construction.

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VOLUME 14 — APRIL 1944 — NUMBER 4

Inclined Mine Shaft Sunk in the Adirondacks

Large Iron Ore Deposits Opened Up in New York State

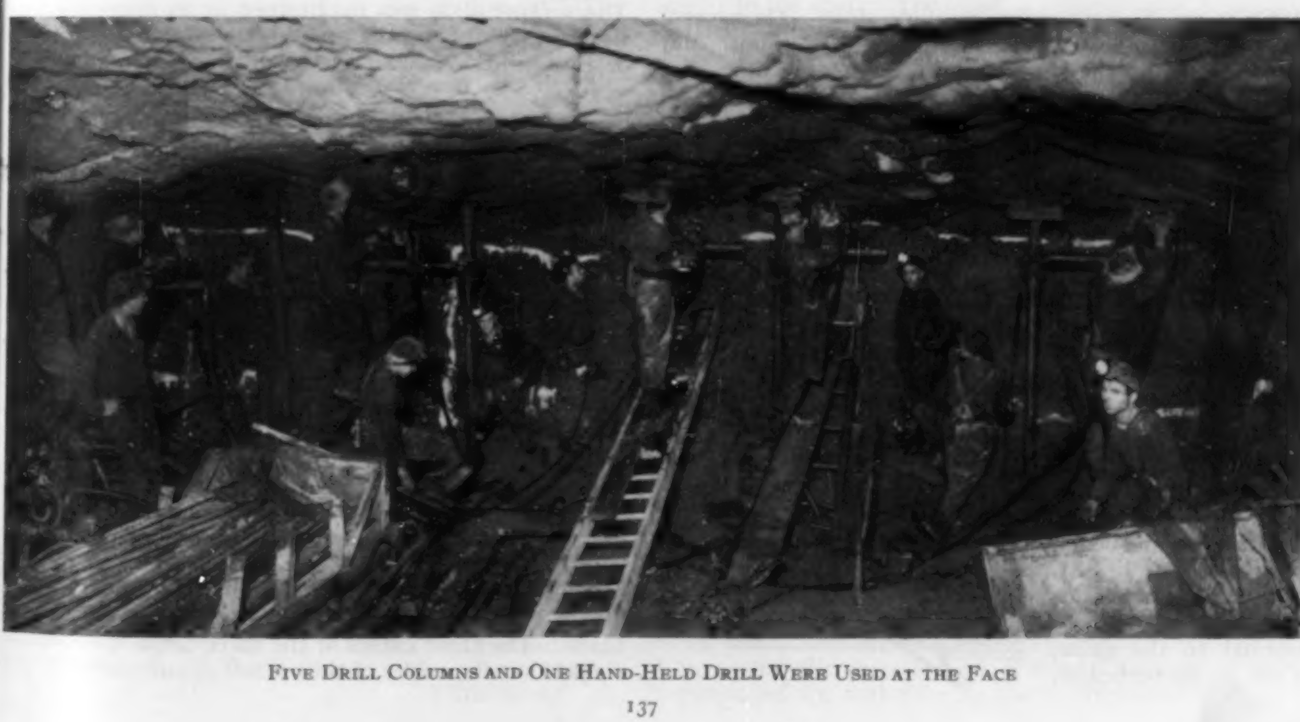
By FRED W. STIEFEL, ASSOC. M. AM. SOC. C.E.
PRESIDENT, STIEFEL CONSTRUCTION CORPORATION, NEW YORK, N.Y.

SINKING a shaft on a slope of 33½° to the horizontal to a depth of 2,000 ft presented many hazards. The shaft at the Republic Steel Corporation's Fisher Hill Mine, near Lake Champlain in northern New York State, will open up iron ore deposits vital to steel production. Heavy timber bulkheads protected workers against rock which occasionally came loose and bounded down the shaft. The work was reported by Mr. Stiefel before the Construction Division at the Society's Annual Meeting in New York.

TO open the Fisher Hill Mine of the Republic Steel Corporation, it was necessary to sink an inclined shaft into the rock and excavate stations, drifts, and ore pockets at intervals (Fig. 1). The shaft is 9 ft 8 in. high by 28 ft 2 in. wide, on a slope of 33½° to the horizontal—a rise of 66 ft in each 100 ft. The plant is planned to sink and operate this shaft ultimately to an inclined depth of 5,000 ft.

This inclined shaft, or slope, is designed to have compartments for two 5-ft-gage ore-skip tracks of 120-lb rail, one 5-ft-gage man-skip track of 60-lb rail, a concrete stairway, and service pipes consisting of a 12-in. compressed-air line, an 8-in. pump-discharge line, and a 4-in. water supply line. The ore tracks rest on long 6-by-8-in. creosoted ties, 15 ft 6 in. long, spanning all four rails. The man-skip track has 6-by-8-in. creosoted ties, 7 ft 6 in. long. The ties are supported by 12-by-12-in. stringers centered beneath the rails. The stringers rest on transverse concrete piers doweled to the rock floor; these piers are spaced 21 ft on centers. Every second pier is equipped with steel bolts welded to the rails, acting as anti-creepers. The entire track structure is provided with crushed rock ballast.

When we investigated the job, the progress being made (under different auspices and separate management) amounted to only 2½ ft per 24-hour day. It was very evident to us, after study, that we could guarantee at least a 6-ft advance a day, and we so stated to the owners, the Republic Steel Corporation. As a result, the Defense Plant Corporation, together with Republic Steel Corporation, entered into a contract with us containing a penalty and bonus clause predicated upon an advance of 150 ft a month.



FIVE DRILL COLUMNS AND ONE HAND-HELD DRILL WERE USED AT THE FACE

SCRAPER SIMPLIFIED MUCKING OPERATIONS
Expansion Pins at Face Hold Blocks for Back-Haul Cables

The cycle of operations consisted of drilling and blasting on the day shift, and mucking on the two succeeding shifts. The average advance was 7.8 ft per day; that in the best six-day week was 60 ft; and that in the best month,

TABLE I. COMPOSITION OF THE THREE SHIFTS USED IN TUNNELING

DAY SHIFT (Drill Crew)	SWING AND GRAVEYARD SHIFTS (Identical Muck Crews)
1 drill boss	1 walking boss
5 drill runners on drifter drills	1 shifter
1 drill runner on hand-held drill	2 miners
5 drill helpers	2 helpers
1 mechanic	1 scraper operator
1 mechanic's helper	1 top signalman
1 pump man	1 bottom signalman
1 nipper	
1 top signalman	

215.5 ft, in 25 consecutive working days. On several days, 10-ft to 12-ft rounds were drilled, shot, and mucked. From the start of shaft sinking, no day went by without the completion of a cycle of operations. The three shifts were manned as shown in Table I.

Each man was paid on an incentive basis, on progress gained above 5 ft per day, proportionate to his scale of wages.

The drilling was performed by $3^1/_2$-in. wet drifter drills mounted on five 8-ft columns (Fig. 2). Even though a full-face drilling and mucking operation is customarily desirable, the steep slope, with the accumulation of water and fine debris at the face, made a modified heading and bench operation preferable. The heading and bench were of equal height. The five columns, instead of being erected normal to the slope, were set up vertically.

There was an average of 78 cu yd in place per round, or 15.6 cu yd per drill per shift. About 526 lin ft of hole was drilled per round, that is, 105 lin ft of hole per drill per shift, or 0.15 cu yd per lin ft of hole. The excavation was performed through some ore and generally through a granitic gneiss. The consumption of 60% dynamite was 6.4 lb per cu yd, using up to No. 12 delay exploders. A V-cut was adopted with the customary relief holes.

As part of the drill round, twenty 6-ft down holes were drilled into the bench at the face, slightly downward or outward from the theoretical alinement of the floor. These holes were drilled through the silt at the face, using 2-in. pipes, 3 ft long, driven to the rock as casings or ferrules. These down holes, when shot, created a trough to grade in the bench of the following round; in this trough the foot blocks of the drill columns were placed. Behind the trough, a solid bench was left as a bump, or ridge, transverse to the shaft. This ridge was shot off by means of down holes drilled with a hand-held drill. This novel method of drilling and shooting the face obviated the necessity of keeping the face entirely clear of water and silt—which must be done to an exacting extent with the full-face method. The face was kept slightly ahead at the left-hand rib, where a pump was continuously in operation to remove drill and leakage water to the nearest permanent pumping station.

On the second and third shifts the mucking operations were identical. They were performed by a scraper slide, operated by a three-drum 50-hp hoist, which was mounted on a 60-lb temporary track in the center of the shaft. The scraper slide was maintained in an operating position 30 to 60 ft from the muck pile. Before the blasting of a round, this machine was pulled far enough away to

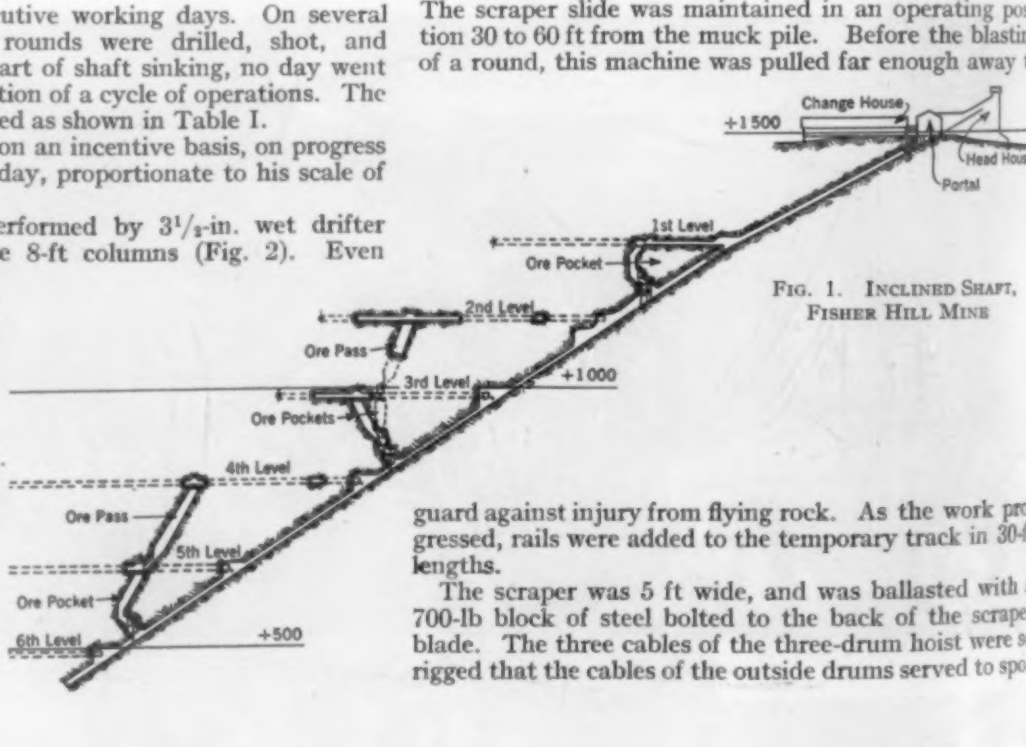


FIG. 1. INCLINED SHAFT, FISHER HILL MINE

guard against injury from flying rock. As the work progressed, rails were added to the temporary track in 30-ft lengths.

The scraper was 5 ft wide, and was ballasted with a 700-lb block of steel bolted to the back of the scraper blade. The three cables of the three-drum hoist were so rigged that the cables of the outside drums served to spot

the scraper at the required loading position anywhere in the muck pile, and the center cable hauled the scraper load over the inclined pan to the unloading position of the scraper.

The two haul-back cables were strung through blocks fastened to ring expansion pins introduced into the left and right sides of the face. All pin-hole and other utility drilling was performed on the muck shifts by drillers who also acted as safety miners. The hoist was mounted above the slide, and the operator stood on a platform on the right side of the machine. Because of the steep grade of the slope, it was necessary to fasten the wheels of the scraper slide to the rails of the track by straps placed around the wheels and hooked under the track rails. These served not only to keep the machine from rolling downhill, but also to prevent the pull of the hoist from derailing the rear end of the slide.

To minimize pick-and-shovel work, the fine debris, or silt, was cleaned up on the graveyard shift by a 2-in. compressed-air blow pipe, or jet. The material was blown to a pile whence it could be conveniently removed by the scraper. The men who did this work wore goggles for protection against eye injury. At a few locations, the steel roof support was installed without interrupting the shaft-sinking work. It was of steel-beam and column-bent construction, with a concrete roof slab. A 12-in. blower line provided ventilation, the blower being placed in the nearest natural air course.

Looking Up Fisher Hill Shaft
Two Skip Tracks at Left, Man-Skip Track in Center, Concrete Stairway and Service Pipes at Right

EXCAVATING STATIONS AND DRIFTS

When the shaft work reached the location of a station, at each 300-ft haulage level, it was suspended while the station was excavated. The work consisted of an overhead enlargement to provide an overhead track bridge or platform, with a hoisting device, giving access to that particular level for supplies, plant and equipment. The level platforms were constructed of steel beams bridging the shaft, supporting reinforced concrete slabs. The structural work for the stations was carried on while shaft sinking continued.

At each level the drifts were excavated to the right and left of the shaft for a distance sufficient to permit the continuation of shaft sinking while the development work at that particular level was going on, without endangering the shaft workers or the shaft structure itself.

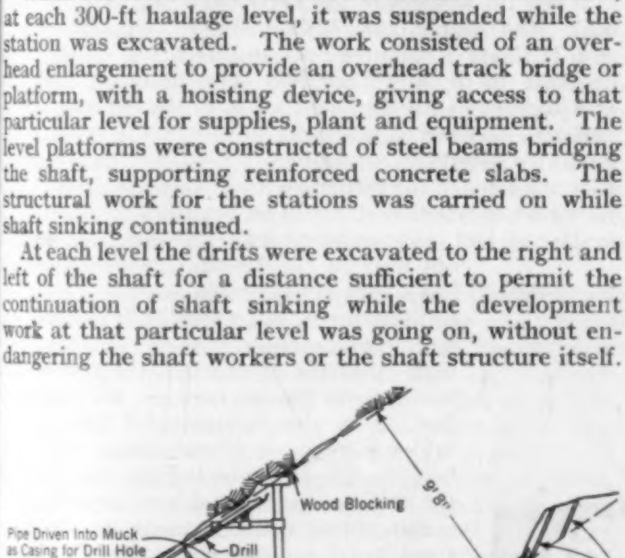


Fig. 2. Typical Drill Mounting at Fisher Hill Shaft

The haulage drifts were driven from the stations using temporary hoppers, for disposal at the stations, until the permanent ore passes leading to the underground ore pockets were available for disposal purposes.

Each ore pocket is located between stations and serves two levels. By means of 17-ton measuring hoppers, ore is disposed of directly to the two 17-ton skips. An ore pass serves the second level above the pocket. The bin and measuring hopper contain 71 tons of steel-plate construction. Each ore pocket was excavated by means of a small raise, with stoper drills, and enlargement was effected by slicing into the bin. This work was carried on simultaneously with the sinking of the shaft. Three service raises were constructed from each ore pocket to the level above. One raise, on a 60° slope, takes off from the pocket on a line parallel to the center line of the shaft. Another, also on a 60° slope, follows a direction at right angles to the shaft. The third, a vertical raise, branches out from the second mentioned half way up its slope. This raise has an outlet on the level above, directly under the ore pass of the next higher level. Two air-operated sliding steel gates control the flow of the ore from the bin to either or both of the measuring hoppers, located above the ore skip tracks.

SAFETY PRECAUTIONS RESULT IN GOOD RECORD

Shaft sinking was carried on under the most hazardous conditions, since work was continuously in progress on the station and ore pocket immediately above. Any object that became loose on the slope would be precipitated the full length of the shaft to the face where the men were working. A heavy timber safety bulkhead, containing space for the passage of the muck skip, was constructed across the shaft to arrest rolling or sliding objects. A man was stationed at the muck-skip opening to warn those below if any object passed through this opening out of control.

The extreme hazard under which the men worked made them realize the need for great care, and safety measures were constantly discussed. There were few but minor lost-time accidents and fortunately no fatalities. The work was carried on by the Stiefel Construction Corporation under the direction of Walter Dunham, general superintendent, and Everett Diehl, engineer.

Coordinating Engineering and Architecture

By Aymar Embury II, M. Am. Soc. C.E.
Architect, New York, N.Y.

It is true that engineering and architecture while in principle having the same function, in practice are often far apart. It is also true that both professions suffer from this lack of common interest and understanding. In an address before the Structural Division of the Society at its Annual Meeting in New York, Mr. Embury presented this discussion and analysis of the interdependence of the two professions.

It is not difficult to understand how the professions of engineering and architecture became separated. Physics and mathematics progressed rapidly during the early nineteenth century and technological procedures kept pace with them, so that there was a vast new body of knowledge to be acquired before a man was sufficiently equipped to design the more complicated structures which an advancing civilization demanded. Specialists developed, some becoming architects and some engineers. Each lost much of value during this process. The engineer concerned himself primarily with strength and economy, the architect with plan and the appearance of things. All four elements are necessary to the ideal structure, and yet life is too short for anyone not a genius to become thoroughly trained in all.

The results of this unfortunate, although inevitable, separation of functions were early apparent. The architect concerned himself more and more with the appearance of things, abandoning knowledge of structure to the engineer. Also, perhaps partially because the architect failed to acquire much of the new knowledge regarding strengths of materials, we had such anachronisms by very capable men as the revival of "Romanesque." This was characterized by walls of incredible thickness with tiny openings in a reversion to the procedures of a thousand years ago, when knowledge of structures was meager.

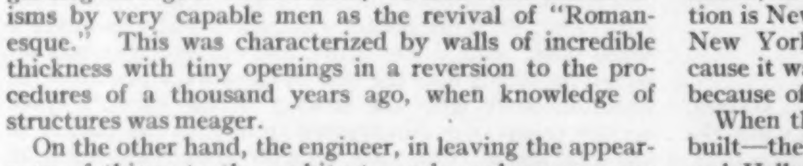
On the other hand, the engineer, in leaving the appearance of things to the architect, made perhaps an even more serious error, judged by the effect on American civilization as expressed in its monuments. Concerned only with the strength and the economics of structures, for many years he abandoned all thought of the esthetic effect of his work, and produced a series of bridges of appalling ugliness which have unfortunately endured because of their utility. Take, for example, the large group of bridges over the Hackensack and Passaic rivers in the Jersey Meadows and over the Harlem River in New York—to use only examples in the neighborhood of New York.

These have been accepted by the public in blind admiration of the knowledge necessary to their design without considering that they could very easily have been as beautiful as they are useful. But they remain, while much of the work of the architects of the same period has been destroyed because of changes in our mode of life. In many of the older bridges, built before the traditional union of architect and engineer had been forgotten, appearance was carefully considered even by men whose training was not primarily architectural.

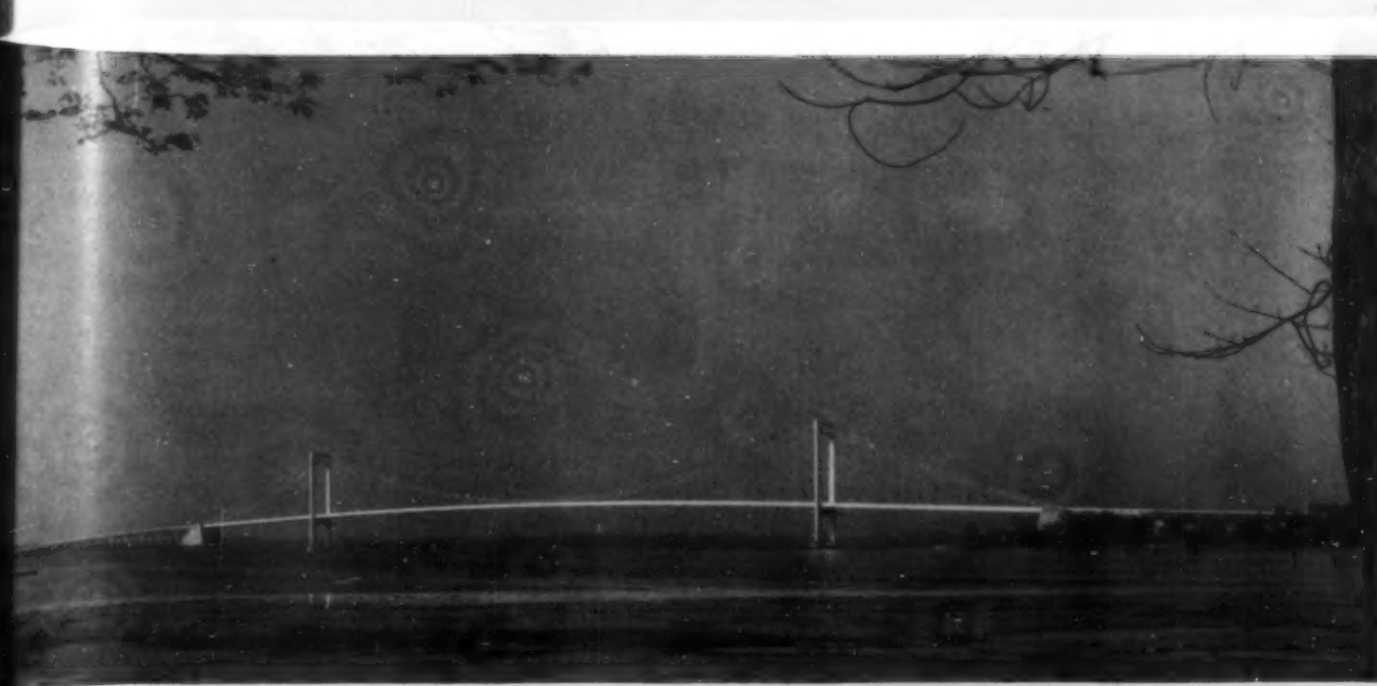
In 1818 Thomas Telford, chiefly remembered as a highway engineer, built what I understand is the first modern suspension bridge from Bangor, Wales, to Anglesea Island, and obviously the appearance of the bridge was as carefully considered as its structure. The Menai Bridge, built as late as 1850 by an engineer, Robert Stevenson, is a superb piece of architectural design. Of course in their relation to the history of civilization, these are "modern" bridges. In the same tradition is New York's own Brooklyn Bridge, regarded by all New Yorkers with admiration and affection, not because it was the longest suspension bridge of its day, but because of the sheer beauty of its design.

When the bridges of the early twentieth century were built—the Manhattan, Williamsburgh, Queensborough, and Hellgate structures—an architect was called in to decorate them after they had been designed, and this architectural embellishment of a predetermined structure was considered sufficient to satisfy the growing demand for beauty in structures. It was not then realized that the lines of the structure itself were the determining factor as to whether it would be beautiful or ugly. As a matter of fact, this architectural embellishment worked out well on the Manhattan Bridge, which has a very considerable amount of extraneous ornament, but so skillfully designed by a very competent architect—Thomas Hastings—that the span itself, the towers, and particularly the anchorages, are genuinely fine. But the fundamental lines of the bridge were good. In the latest of the four bridges, the Hellgate Bridge, the shape of the structure was considered as well as the architectural embellishment on the main span, but I cannot believe that the same is true of the long approaches.

It is only within the last few years, particularly through the vision of New York City's Commissioner of Parks, Robert Moses, that bridge approaches in the city have been made ornaments to the neighborhoods in which they occur, rather than detriments. Even before Mr. Moses' contribution, the Port of New York Authority



A Bridge That Is Set Off by Flat Surroundings
Crossing of the Chesapeake and Potomac Canal, St. Georges, Del.



Omission of Extraneous Detail Emphasizes the Grace of the Suspension Span—Whitestone Bridge, New York

had, in the George Washington Bridge approaches, proceeded very far toward improving instead of harming the contiguous neighborhoods.

There is no excuse for ugly engineering structures. Ugliness and economy by no means march hand in hand. One of the most beautiful things in America is the Bixby Creek Bridge, built by the California State Highway Department. Several of the great dams built in recent years in the West are as superb esthetically as they are sound structurally. In Baltimore are the splendid arch spans of the Howard Street Viaduct, for which the J. E. Greiner Company were the engineers. I remember one day passing by train through southern Louisiana past miles of flat, dull forest, crossing the Atchafalaya River and seeing to the south the lovely, airy spans of the K-braced highway bridge over the river, designed by the Louisiana State Highway Commission.

Now, there is one thing common to all these structures—they are functional. The term functional is no longer a new one in the language of design, but although everybody knows about it, nobody knows what it is. In modern usage the word describes a structure without ornamentation except that which arises from its basic load-bearing elements. Implicit in the meaning of "functional" is the principle that the structure shall not be distorted, for the sake of appearance, from the form it would naturally assume.

It is a word architects love to use, especially those who have found that they can torture buildings into unusual forms of a layman's knowledge of what the cantilever can accomplish. Whenever an architect says his building is functional, I am pretty well convinced that it is ugly. Conversely, I am even more convinced that no engineering structure which is not strictly functional can be esthetically satisfactory. Engineers have too often employed architects to decorate their bridges with a few curlicues of iron. These excrescences cost money and add nothing to the structural value, but the architect is apparently under the impression that by some magical process a mule can be made to look like a horse. These are both functional animals—they can both carry loads to some extent and both can draw wheeled vehicles with ease: they are functional animals, but the horse as a rule is esthetically satisfactory and the mule is not.

So, in the design of engineering structures there are many possibilities of completely functional design, some of which may be esthetically satisfactory and some the reverse, and the only way to find out which is which is to draw them on paper. I do not mean that all engineers, any more than all architects, will be good judges of their own work but at least most of them have sufficient taste and judgment to pick the best, or the better, of several designs when they realize what they will look like. But they usually do not take the trouble to find out; even the mechanics of finding out is partially unknown.

A good many bridges are designed with stress diagrams and a slide rule. A more careful engineer makes a diagrammatic elevation of one side of the structure, although this is not much of an indication as to how the bridge will look in perspective. No direct elevation shows the transverse wind bracing, or gives any idea of the confusion of form which occurs in a diagonal view. Part of the training of an architect is the sharpening of his constructive imagination. He is trained to see in his mind's eye a picture of how his plan will appear when it is enclosed in walls, colored by the material he has selected, and with windows shining with new glass. But there are very few who trust their constructive imagination enough to design a building without putting down the facts in perspective.

A lot of bad design by both architects and engineers is due to the human weakness for employing in a new

Anchorage of the Manhattan Bridge, New York, Is in Harmony with Fine Architectural Traditions

A BRIDGE MUST BE VISUALIZED IN PERSPECTIVE
Driver's View of the Manhattan Bridge, New York

problem a solution which has been satisfactory in a former one, completely ignoring the fact that the surrounding conditions may be entirely different. The training of an architect makes him a little less apt than the engineer to substitute memory for imagination. The architect starts with a sketch and the engineer with a slide rule. The slide rule will only prove that the design will carry an H-20 load, while the architect's sketch will show him immediately that the building which looked so well in one location looks anything but well in another. Referring again to the Bixby Creek Bridge, this is a superb design in its particular location, but I cannot imagine anything worse in the flat country over the Chesapeake and Potomac Canal, with a couple of miles of plate-girder approach ramps attached to each end.

One of the shrewdest observers among my engineer friends has suggested that the methods used in the engineering schools must be modified before engineers can begin to see things in the round—to visualize in perspective. He says that it is a never-failing source of interest to him to see an architect work with tracing paper—making very quick, inexact drawings, but close enough to fact to enable him to see at once whether or not he is on the right track. An architectural draftsman will habitually make five or ten or fifteen sketches in the time that it takes an engineering draftsman to make one laborious calculation. As soon as these rough sketches are made, their maker is able to see by inspection, and by what he knows about structures, whether what he has in mind is a rational solution.

If, for example, an architect has the problem of a street crossing, he can determine almost at once whether a single span with a deep girder, a series of girders with intermediate supports, a rigid frame, or a brick arch will look the best. An experienced man can also make a good guess as to the costs of the several structures, and then if two or three of them happen to have about equal merit esthetically, some further computations will immediately enable him to decide which to use.

The architectural schools train their students by giving them problems without indicating the solutions. The engineering schools, as I have seen them, tend to require an analysis of a solution when the problem itself has not been stated. It would seem that, occasionally at least, an engineering school should give its students the problem first and then require them to analyze their solutions as far as they are able to do so. I do not mean that a first-year man in engineering school should be required to figure a rigid frame, but I am certain that the student's interest in his problems, and particularly in the esthetic side, would be more stimulated by a problem calling for a small bridge over a stream in a specified terrain, permitting the student himself to choose the type, than by a problem indicated simply by the statement, "I want you to design a fixed arch 120 ft long, 27 ft wide, and 42 ft high above the roadway."

Architecture and engineering are not so very different. As a matter of fact, they are essentially one and the same thing, although most engineering problems deal with heavy construction calling for the use of machines, and most architectural problems deal with light construction for the use of human beings. Nor do engineers lack esthetic perception any more than architects do a sense of structure. The inventor of the truss was Palladio, an architect. For many thousands of years before engineers as such entered the picture, buildings were erected, and stood up, and were beautiful. It is manifestly impossible that in the last fifty years there should have suddenly been evolved two entirely different breeds of men—one having esthetic sensibilities only, and the other only a sense of structure.

However, all construction problems have become so complicated in the last half century that very likely the ideal structural design is made by architects and engineers working together from the beginning of the problem in a true partnership of ideas. The architect habitually calls in the engineer to help him solve structural problems, and it might be in the best interests of engineering design if the engineer were to call in the architect to help him solve problems of esthetics.

SURROUNDINGS MAKE A DIFFERENCE
Rainbow Bridge, Niagara Falls, N.Y.

Control of Flood Debris in San Gabriel Area

Work of Los Angeles County Flood Control District Described

By Paul Baumann, M. Am. Soc. C.E.

Assistant Chief Engineer, Los Angeles County Flood Control District, Los Angeles, Calif.

Enormous quantities of materials are moved by nature's most destructive phenomenon—the mountain flood. To control these floods and thereby check their eroding force, numerous reservoirs have been created by the construction of check dams. On the watershed of the San Gabriel Mountains, where unusual conditions create severe floods, such control was imperative, as described by Mr. Baumann in this paper, originally presented before the Waterways Division at the Los Angeles Convention of the Society.

Since its inception in 1916, the Los Angeles County Flood Control District has concentrated its efforts on the erection of a first line of defense for the protection of life and property in the highly developed valleys below the San Gabriel Mountains. For the past eight years the U.S. Engineer Department has been engaged in the construction of a second line of defense. This area has frequently suffered the disastrous onslaught of the mountain flood. While in general such characteristics as steepness of slope, inherent instability, and the preponderance of rock and consequent low permeability are common to practically all mountain watersheds, a number of significant features are typical of the San Gabriel Mountains and have a distinct influence on the meteorological, hydrological, and geological factors governing floods.

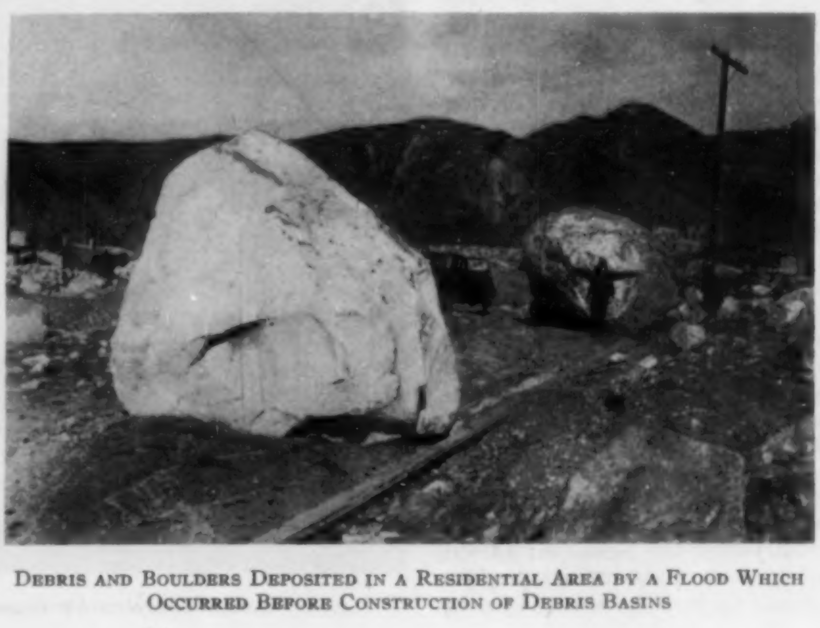
The meteorological factor is primarily due to the location of the mountain front near the ocean, but also to the direction of approach of the principal storms, which is at right angles to the mountain front. The topographic configuration of the range is likewise influential. The mass elevation is of the order of 4,000 ft and the elevation of individual peaks ranges from 5,000 ft in the west to 10,000 in the east. The two combined cause a lift of approaching air which has been in close contact with the surface on its way from tropical regions across the Pacific Ocean, and which as a result has a high relative humidity. These warm, moist, and light air masses are pushed along their easterly path by cold, dry, and heavy air masses or density currents, which pour out from the polar "weather factory" at a frequency of about once a week. In the course of its travel, this warmer air reaches our coast, and being wedged between the cold air front and the mountain front, rises at an accelerated rate. This situation is accentuated by a strong onshore wind. The pattern for a flood-producing storm is then potentially complete.

Rain drops fall about 25 ft per sec. Hence if the air rises at a rate exceeding 25 ft per sec, raindrops are carried upward and moisture is concentrated. If such a mass is carried across the mountain range and drops beyond it, high intensity of rainfall results. This so-called orographic condition led to the record intensity of 1 in. per minute for one minute at Opid's Camp on April 5, 1926. The maximum 24-hour rainfall at this location amounted to 12.29 in. This storm, which lasted for nearly five days and which yielded a total of 24.16 in., swept on in three separate waves with periods of no rainfall, lasting several hours, in between. Hence each of these waves represented a separate air mass subjected to intense orographic effect.

Major storms are due to relatively large air masses. Because their vertical dimension is much greater than the height of the mountains, they are not as acutely affected as are the smaller masses. They tend to produce steady, heavy rains at a rate of the order of 1 to $1^1/_2$ in. per hour for many hours. Again, Los Angeles County registered a record of at least nationwide scope on January 22 to 23, 1943, when 25.83 in. fell in 24 hours at Camp LeRoy, formerly Hoegee's Camp, on the Big Santa Anita watershed.

Runoff Studies

Hydrological studies of mountain areas have shown it necessary to consider three principal categories of runoff—surface, subsurface, and base flow. While surface and base flows are a matter of common knowledge and are typical of most watersheds, subsurface flow did not get proper recognition until the flood of March 2, 1938. In brief, this flow tends to flatten the peak but not to reduce the volume of the storm runoff as does the base flow. The rate of rainfall which will produce subsurface but not surface flow is of the order of $^1/_2$ to 1 in. an hour, with base flow below the lower limit, and the beginning of surface flow above the upper limit. As surface flow increases, subsurface flow increases too. Subsurface flow must therefore be expected to be the major contribution to the flood hydrograph during major storms. Over-all runoff coefficients based on a 24-hour yield for major storms vary from one-third to two-



Debris and Boulders Deposited in a Residential Area by a Flood Which Occurred Before Construction of Debris Basins

TYPICAL DEBRIS BASIN, ABOVE LA CRESCENTA, CALIF., COMPLETED IN 1936, LOOKING UPSTREAM

thirds, depending primarily on the initial condition of the watershed, and above all on antecedent rainfall. In general, about 12 in. of rainfall is required before heavy runoff may normally be expected.

The cause of this subsurface flow is the fractured condition of the rock formation. The consequent lack of bond and stability is closely related to debris production of both the floating type, commonly known as "trash," and the dragging and suspended type, called "detritus." Denudation of watersheds by fire likewise produces large quantities of debris. So prominent a part is played by debris during major floods that the phenomenon is often more intimately related to soil mechanics than to hydraulics.

Nature provided debris cones below the canyons for extracting debris from the water. In the course of development of the Los Angeles metropolitan area, however, these cones with few exceptions were subdivided and settled upon, particularly during a period of relative absence of floods. The natural process of debris extraction was thereby much curtailed if not eliminated, and artificial means for this purpose had to be provided in the form of dams and basins. The latter are used in connection with small watersheds up to a few square miles and serve primarily to extract the solids from the mixture, while the dams further serve to regulate the liquid content in accordance with conditions along the stream channels below.

The quantities of debris and trash produced during major floods are quite impressive. Measurements after the New Year's flood of 1934 showed a debris production of up to 100,000 cu yd per sq mile from the watershed above La Crescenta, which had been denuded by fire in the preceding fall. Permanent basins along the San Gabriel Mountain front have since been designed to store similar quantities of debris. The design is based on a debris slope between one-third and two-thirds of the natural stream slope at the basin site. The variation in the slope is governed by the size and character of the debris.

Basin spillways are designed for maximum flow of water swollen in bulk 100% by debris. Hence it is assumed that during capital floods liquids and solids are equal in volume. Actual observations at basins during and after floods of variable magnitude have disclosed flows consisting of 85% solids. This is the consistency of not very "sloppy" concrete.

The capital flood for which all the permanent works in the District are designed, is expected to occur once in fifty years. In only one instance has the District's capital flood figure been reached or exceeded by actual flow as to both peak and volume. This happened on March 2, 1938, at Dam No. 2 on the West Fork of the San Gabriel River. Including the base flow from antecedent rainfall, this flood between midnight of March 1 and midnight of March 4 produced at this location about 18,000 acre-ft of water and 1,500 acre-ft of debris from a drainage area of 40.40 sq miles. The peak of the flow was 23,800 cu ft per sec. During the same flood ten major dams with an aggregate flood storage of 87,000 acre-ft regulated and conserved some 180,000 acre-ft of water, and extracted some 12,500 acre-ft of debris, exclusive of trash. The trash, ranging from large logs down to tiny twigs, completely covered the surface of most of these reservoirs, and large piles were jammed between the canyon walls

SLUICING TO REMOVE DEBRIS IN A FLOOD-CONTROL RESERVOIR

at the headwaters. The bulk of this trash was dead wood.

TRASH-RACK DESIGN EXAMINED

During this attack no weaknesses developed in the dams proper; however, inherent weaknesses in appurtenant works became evident. This applies above all to trash racks. The cage-type rack at the upstream end of outlet pipes, conduits, and tunnels, is highly vulnerable and subject to complete clogging and collapse. It simply gets swamped and buried and nothing can be done about it in the face of such a volume of debris.

The riser-type rack has proved in general quite satisfactory, provided it extends far enough above the debris surface to be continuously in contact with water that is relatively free of debris. In this manner it is self clearing. Obviously it must be constructed to stand the pressure from the debris seal in the lower part as well as the impact of the moving mass. A cylindrical or semicylindrical cross section is most suitable. Heavy bars of high rigidity are desirable where the size of the rack permits. They may be built as box sections with sides converging to form an opening between them, the width of this opening being a minimum on the outside and a maximum on the inside of the riser. Trash entering the minimum section on the outside will readily pass through the opening without wedging or jamming. For smaller trash-rack-risers, railroad rails of adequate weight, with the flange turned toward the outside and the head toward the inside, may be used advantageously.

Trash left behind after a flood is removed by mechanical means—such as nets on derricks or slack lines—or it is boomed, beached, and burned. In any event, it can be completely eliminated by relatively simple means and at moderate cost. Detritus offers an altogether different problem. It consists of materials ranging from large boulders to the finest of colloids. It cannot be burned or otherwise destroyed in place, but must be moved bodily out of the reservoir or basin, at least in part, if storage is to be reclaimed.

Basin Shown at Top of Preceeding Page Filled with 150,000 Cu Yd of Debris
Material Was Washed Off 1.84 Sq Miles of Watershed in March 2, 1938, Flood

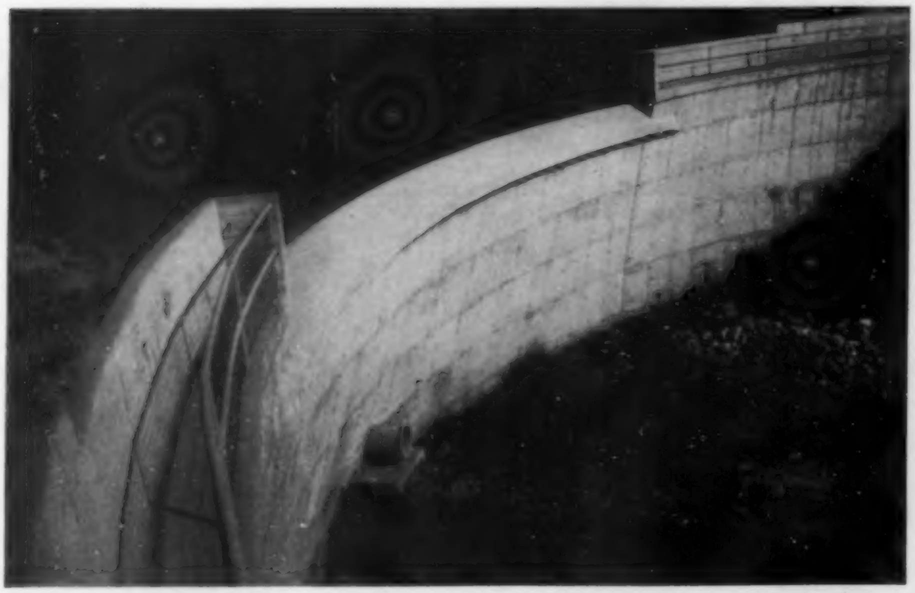
MECHANICAL EXCAVATION OF DEBRIS

Where adequate stream flow is not available, as is the case at most of the debris basins, mechanical excavation is used. After the March 1938 flood, some 700,000 cu yd of debris was excavated from 16 basins at a cost of approximately $225,000. Although this is a large amount of money, it is small compared to the damage to property—to say nothing of life—which would have occurred without the basins. There would also have been the cost of removing the debris from streets, yards, and homes. Incidentally, the average debris production during this flood at the 16 basins was 60,000 cu yd per sq mile, and 3 of the basins collected twice or nearly twice this amount.

Where adequate stream flow is available, which is the case at most of the dams, the debris can be removed by sluicing at a much lower unit cost, that is, at around a cent per cu yd, or approximately $16 per acre-ft. This operation however is predicated upon suitable sluicing facilities, which unfortunately have not been consistently provided. The clear-water conception sometimes triumphed over the debris conception, a decision which is incompatible with conditions on these mountain watersheds. Where this had happened, sluiceways had to be improvised.

The classical idea incorporated in some textbooks is that debris

Spillway of San Gabriel Dam No. 1 Discharging Desilted Flood Waters



DOWNSTREAM FACE OF THE SUNSET CANYON DAM—A TYPICAL CONCRETE-ARCH DEBRIS STRUCTURE OF THE LOS ANGELES COUNTY FLOOD CONTROL DISTRICT

should be sluiced when the reservoir is substantially full. But this cannot be done except in the form of underflow with particles in suspension, or in the immediate approach to the outlets.

The bulk of the detritus must be moved out of the reservoir by the kinetic energy of the water. This means stream flow. In other words, to transport the material it takes water power equal to the mechanical power required to excavate, load, and haul it. The amount the water will carry as it flows across the bottom of the reservoir is principally governed by its depth and the slope. It is more a question of drag due to weight than of impact due to velocity. The initial increase in bulk generally amounts to about 25%. It gradually drops off to about 5% with a drop in stream flow. The average bulking during a sluicing operation may be expected to amount to about 10%. These figures necessarily vary with conditions.

In general, about 75% of the detritus deposited in reservoirs is of such size as to be removable by sluicing if suitable facilities are available. This material ranges from the finest particles up to about 6-in. boulders. The remaining 25% could only be removed mechanically. In most cases the cost of such removal would be prohibitive. We are therefore faced with the eventual loss of reservoir storage. The lifetime of the reservoirs depends on two principal factors: the elements that are largely beyond our control, previously mentioned, and the reduction in the rate of erosion, which is largely within our control.

The gradual filling of a reservoir with debris tends to reduce erosion. It will not only prevent further entrenchment of the stream and progressive instability and collapse of canyon walls, but will lend support to the canyon walls well above the original streambed. This will extend for a distance upstream from the dam which, by virtue of the debris slope, considerably exceeds the original length of the reservoir. Hence each of these mountain dams will eventually accomplish—quite by accident perhaps—a piece of upstream engineering.

Obviously, in sluicing reservoirs we deal in terms of acre-feet rather than of cubic yards. Hence, in spite of the low unit cost of sluicing, the recovery of lost storage to the extent mentioned is far from being a bagatelle financially. Considering the original cost of storage at these dams, however, this expenditure is fully justified. The average cost per acre-foot of original storage for the ten dams in question was approximately $620. The total cost of lost storage behind all the District's 16 dams after the March 1938 flood amounted to nearly 3¼ million dollars!

This necessarily raises the question: What can be done about the debris situation? There appears to be only one reasonable answer—reduce erosion to a minimum. This truth has been recognized in this area, and a campaign in upstream engineering was launched some three decades ago. Several thousand check dams were built on a number of mountain watersheds. But the stabilization of a watershed by these or similar means requires more time than was available. The rapid development in the valley area called for immediate protection. This was created by the dams and basins as the first line of defense at a cost of over 40 millions.

In recent years an extensive program of upstream engineering by the U.S. Department of Agriculture has been under way. It includes reforestation for soil stabilization and will require considerable time to become effective. In the meantime, the first and second line of defense, in the form of dams and basins, will continue to protect the valley from floods and particularly from the onslaught of debris.

WIRE-BOUND CHECK DAM FOR EROSION CONTROL

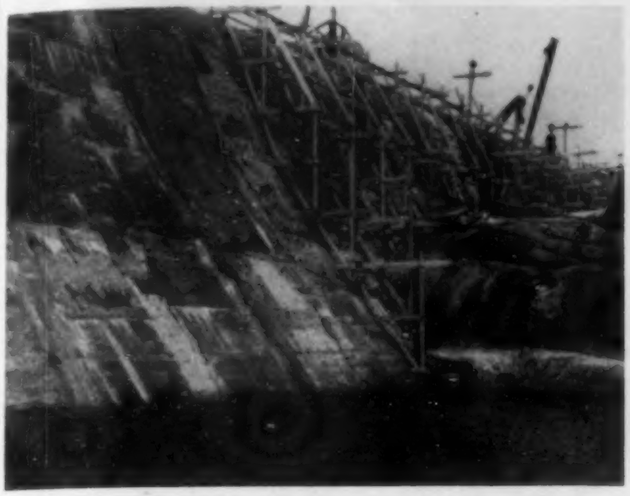
Gouin Dam, Canada, Repaired with Gunite

By O. Graham

Formerly Chief Engineer, The Quebec Streams Commission, Montreal, Canada

Alternate freezing and thawing resulted in serious disintegration of the surface concrete of Gouin Dam, Quebec. Satisfactory repair was accomplished by applying a thin coating of concrete over all affected areas. To avoid the use of forms, pneumatic gun type placing equipment was used. An interesting feature of the work was the use of floating caissons to dewater upstream sections of the dam. This paper by Mr. Graham was presented before the Power Division at the Los Angeles Convention of the Society.

Gouin Dam is on the Upper St. Maurice River, 52 miles north of Sanmaur, Quebec, a station of the Canadian National Railway, 75 miles west of the city of La Tuque. This power structure was completed during the winter of 1917–1918, and its operation has



Downstream Face of Gouin Dam at Start of Repair Work

always been satisfactory. However, since 1930, disintegration or scaling of the concrete has increased rapidly. This continuous spalling of the surface was caused by the freezing action of the water, which filtered into the pores of the concrete.

The greatest deterioration was on the upstream face, at the level at which the water is generally kept during the winter season. The bottom sluice-gate section suffered the most. This is because the surface of the reservoir does not freeze in front of that part of the dam, and consequently the concrete there is more exposed to frost action. On the downstream face, the surface of the piers of the sluice section showed an advanced stage of deterioration. This can be explained by the fact that these piers, besides being affected by frost, are subject to the erosive action of the flow through the sluices.

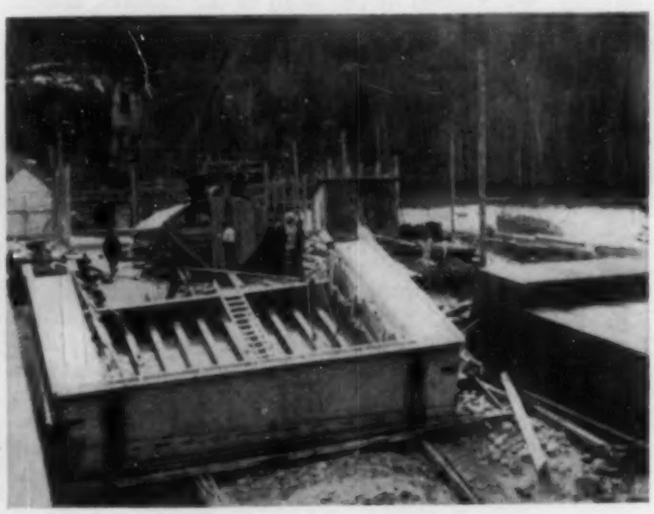
The top of the dam, as well as the downstream face, is exposed to rain and to melting snow. The downstream face of the bulkhead section and of the sluices did not suffer any damage above El. 1317, where it is vertical. Deterioration was more pronounced near expansion joints than elsewhere. In some places, the construction joints show a coat of laitance. At some of these joints the concrete had deteriorated to a depth of as much as 10 in.

To remedy this condition and to stop the continuous deterioration of the exposed concrete, the Quebec Streams Commission, of which the writer was chief engineer, recommended that the surfaces of the dam be covered with a protective and waterproof layer of cement mortar.

The repairs, in order, consisted of unwatering of the upstream face to about El. 1303; chipping or removal of deteriorated or loose concrete and cleaning of the newly exposed surfaces; application of a metallic coating; waterproofing of the expansion joints; fixing of special anchorages to hold in place the wire mesh used to reinforce the new concrete layer; placing of the wire mesh; application of a layer of mortar (gunite) with "cement guns"; and special repairs to the ten sluices and tunnels.

In carrying out these repairs the greatest difficulty was in unwatering the upstream face. The level of the reservoir could not be lowered because it was necessary to insure, during dry periods, the regulated flow guaranteed by contracts with plant owners on the river.

Steel Sheet Piling Used for Cofferdam on Upstream Face of the Gouin Dam



Floating Steel Caisson Which Was Attached to Face of Dam in Deep-Water Sections

FLOATING CAISSON ATTACHED IN FRONT OF A SLUICEWAY

TIMBER CAISSON APPLIED TO AN ANGLE ON THE FACE OF THE DAM

The upstream face, where there was less than 25 ft of water, was unwatered by the use of steel sheet-piling cofferdams driven to the rock surface, or as far as possible, and held in position by wooden frames resting against the face of the dam. The length of these cofferdams varied from 40 to 80 ft, according to the topography of the river bed. They were 9 ft 3 in. wide.

As there was very little earth on the rocky bed of the reservoir near the dam, it was difficult to make the dams watertight at the foot of the sheet piling. In order to do so, a row of bags filled with a mixture of sand and cement was placed beforehand at the base of the piling. As a safety measure, an earth toe-fill was deposited. In deep water the dam surface was unwatered by the use of two floating steel caissons and five wooden ones. These caissons had only three walls and a bottom, as the face in contact with the dam was open to allow the repair work to be done. The two steel caissons had a rectangular form, 6 ft wide and 23 ft high; in length one was 25 ft 5 in., and the other 27 ft 9 in. Each was provided with air-tight buoyancy compartments, two vertical and one horizontal. These compartments could be filled with water and emptied at will, so that the caissons could be floated and maintained in the position desired. The vertical compartments were attached to, and formed part of, the sides of the caisson. The horizontal compartment was placed at the head of the caisson, and its top was used as a platform for the workmen.

MAKING CAISSONS WATERTIGHT

In order to increase the watertightness of the caisson, pieces of hardwood 4 in. thick were bolted on the edges, resting against the face of the dam. Attachment to the dam itself was secured by means of anchor bolts placed in the upper part and on each side of the caisson. Joints between the wooden strip of the caisson and the face of the dam were calked by a diver with pieces of heavy canvas and wooden wedges.

As the working chamber of the caisson was unwatered, the vertical buoyancy compartments were filled simultaneously, so as to counterbalance the uplift action. Repair of each section required an average of five days, one day for setting, dewatering, and removing the caisson, and four days for the cleaning and concreting work on the dam. The two steel caissons were used in a total of 43 positions to repair the upstream face, 20 ft high by 770 ft long. Parts adjacent to the corners of the piers of the sluice sections were unwatered by means of the five wooden caissons. These were of circular form, 24 ft 6 in. high, and consisted of a steel frame and timber sheeting 4 in. thick. Empty steel drums floated these caissons.

PREPARATION OF THE SURFACE

All defective concrete was removed by pneumatic tools, until a solid and sound matrix was exposed. The new surface was thoroughly cleaned by sand-blasting, then by compressed air, and finally by a jet of water, to obtain a clean, solid toothed surface entirely free from loose particles, dust, or foreign matter. From 2 to 10 in. of loosened concrete was removed; the average was $3^1/_2$ in.

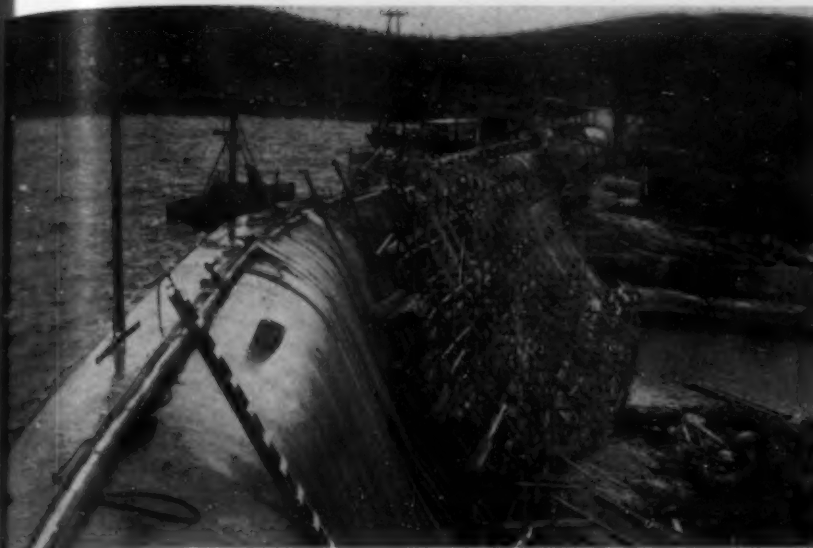
Concrete thus cleaned was covered with a metallic mixture to fill up the pores and to make it impervious to

REINFORCING IN PLACE OVER PREPARED SURFACE ON UPSTREAM FACE OF SLUICE GATE

seepage. This mixture is composed mainly of cast-iron powder and an approved oxidizing agent. It was diluted with water and applied with brushes. It must be well oxidized before the layer of gunite is applied.

Vertical expansion joints were cut to an average depth of 8 in., then properly calked with oakum and covered with asphalt plastic compound 2 in. thick. The joints were then rebuilt with asphalt or cork strips $^1/_2$ in. thick.

For reinforcement a rectangular mesh fabric was used



Spillway of Dam Partially Repaired

Spraying Concrete Into Place

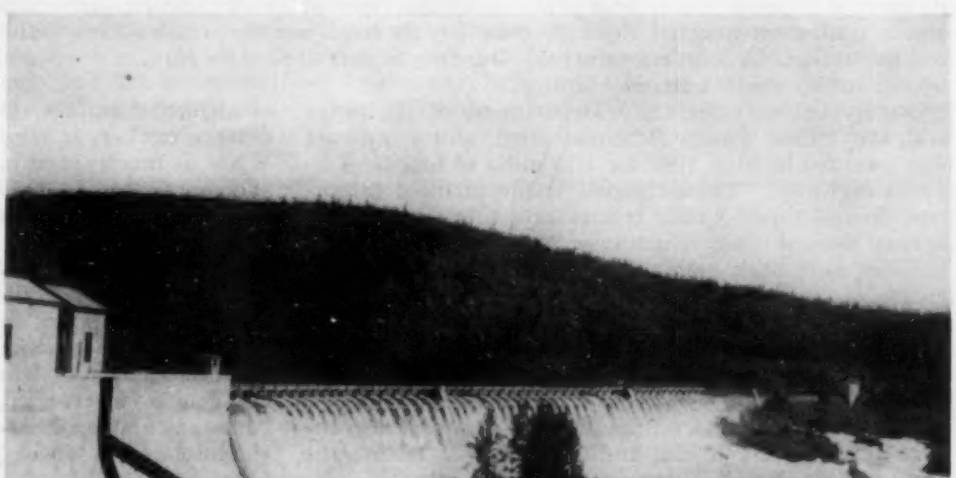
f No. 6 gage wires spaced 3 in. on centers in each direction. In order to support the mesh and to secure it to he old concrete, anchors were placed 20 in. on centers, taggered. Holes about 2 in. deep were made in the oncrete for that purpose. The anchorage itself consisted of steel nails of a special make, $^1/_4$ in. in diameter nd 5 to 12 in. long, and a two-unit expansion shield, two f lead and two of steel. The nails were then bent up nd over the wire mesh. This mesh was placed $^1/_2$ in. rom the old concrete face and $1^1/_4$ in. from the finished urface. A second layer of mesh was used when the hickness of the lining exceeded 3 in. The reinforcement as cut at all the expansion joints.

DENSE SURFACE COATING USED

The impervious surface coating consisted of a mixture f 3.5 cu ft of sand per bag of portland cement, the proportion being four parts of sand to one of cement. pecial care was given to the grading of the sand in rder to obtain a very dense and impervious mixture. he equipment for the application of the mixture consisted of air compressors; a pneumatic placing machine; he necessary lengths of hose or air, water, and the mixture of sand and cement; and nozzle to shoot the mortar nto the faces to be covered. ngredients were dry-mixed on platform, then passed through $^1/_8$-in. sieve before being laced in a hopper. The mixture was then put into the pper chamber of the blower, hich was alternately under ressure and free from pressure. Thence it flowed into he lower chamber of the machine, which was always under pressure. From this last hamber, the dry mixture sand and cement) was pushed y compressed air through the ose to the nozzle, where the ater was added. The mixture was shot at the concrete urfaces from the nozzle under high pressure, and accumulated to form a coating of the required thickness.

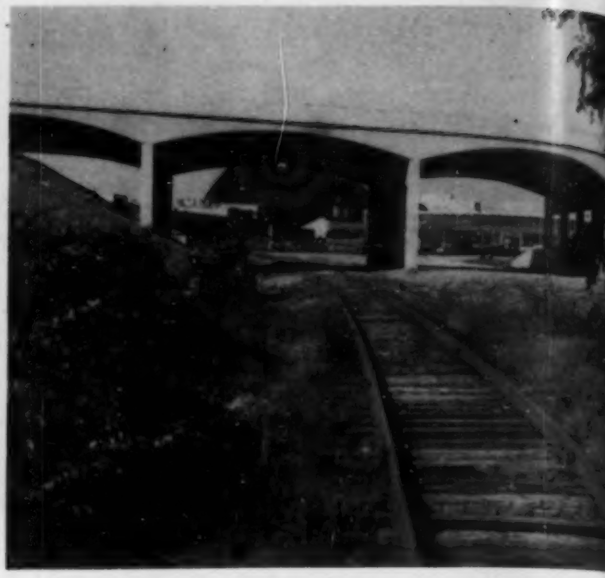
With this method each layer must not be more than 2 in. thick, otherwise there is danger that the wet concrete will sag under its own weight and not adhere to the surface. Each successive layer must have begun to set before the next is applied. A considerable part of the material rebounds from the surface and from the reinforcing mesh. The thinner the layer, the greater is the loss of material. This loss was estimated at 70% when a lining $^1/_2$ in. thick was applied to the outside walls of the gate houses, and about 37% on the faces of the dam itself, where the thickness varied from 2 to 12 in., the average being $4^1/_4$ in. An admixture was used in the final layer on the upstream surfaces and the top of the dam to prevent setting cracks. The surface of the last layer was screeded and floated with wooden trowels.

It is to be noted that this process eliminates the building of forms. Had forms been used, the concrete would have had to be much thicker and its homogeneity would have been much less than that obtained by the "cement-gun" method.



Gouin Dam After Repair

Completed Highway Serving the Aircraft Plant
Twin Traffic Lanes Are Designed for a Speed of 70 Miles an Hour



Overpass Separates Railway and Highway Traffic
Falsework Was So Set Up That Rail Traffic Could Be Maintained

Wartime Access Highway Has Postwar Value

By Hal G. Sours, Assoc. M. Am. Soc. C.E.
Director, Ohio State Department of Highways, Columbus, Ohio

Vast expansion of the Goodyear Aircraft Plant near Akron, Ohio, created urgent need for adequate highway traffic lanes in the vicinity of the company's grounds. The Ohio Department of Highways and the Public Roads Administration cooperated in developing the project. Plans were carefully prepared so that the traffic artery, in addition to serving a wartime need, will later become part of a permanent belt highway bypassing Akron on the southeast. As reported by Mr. Sours, over 70% of the employees use private cars in traveling to their work at the plant.

A forecast made in 1940 indicated a 325% increase in employment at the Goodyear Aircraft Corporation plant near Akron, Ohio, and thus showed the necessity for increased capacity and more fluid movement of traffic on state route U.S. 224 and connecting roads in the vicinity of this defense industry. From Pearl Harbor came the spark that was to change this secondary high-maintenance-cost highway into one of the typical new access routes constructed throughout the nation. A joint cooperative agreement was entered into promptly between the Ohio Department of Highways and the Public Roads Administration, and a contract was awarded in May 1942 for 1.79 miles of four-lane divided highway. The estimated traffic justified a four-lane divided type. Traffic counts soon after the road was opened showed 9,328 vehicles per 24-hour day, and 1,214 vehicles in a peak hour. This will quite probably increase.

Postwar Usefulness Assured

Future usefulness of this improved highway is assured, as after the war it will become a permanent link in a belt-line route around southeastern Akron and also the first link in a major east-and-west highway across the state. The relation of new construction to the old state route U.S. 224 is shown in Fig. 1.

The design provided for two 24-ft concrete pavements, of typical section, separated by a paved medial divider 4 ft wide, which merges into a 30-ft seeded medial divider near the east end of the project. From the 4-in. sandstone curb, the shoulder slopes 1/4 in. per ft to the right-of-way line. The major approach ramp from state route U.S. 224 at the entrance to the plant consisted of two 12-ft lanes separated from a single 12-ft lane by a 2-ft asphaltic medial divider. Construction of the approach ramp included one continuous concrete-beam bridge to separate the traffic on this ramp from through traffic. Fortunately the old route served admirably during the construction of this bridge and of the new highway, and outside of physical hazards such as curves and poor condition of the road surface, there was little inconvenience to defense workers in their movements to and from work. While as much speed in construction was maintained as was practicable, haste was not so urgent as in some other parts of the country, where no roads were available to serve new plants.

Before the new highway was designed, surveys of traffic volume and direction were made by the Division of Traffic and Safety of the Ohio Department of Highways (Fig. 2). The anticipated major conflicting movement for a one-half hour volume, where the flows of 180 and 194 vehicles intersected the 324 stream of traffic, did not cause any appreciable delay, since the 324 vehicles cleared the intersection ahead of the incoming traffic.

A Safe Speed of Seventy Miles an Hour

Two entrance lanes and one exit lane on the approach ramp were designed for a lane capacity of 750 vehicles and a safe speed of 35 miles an hour. State route U.S. 224 was designed for a maximum hourly lane capacity of

He constructed concrete sills on the edges of the rock

,000 vehicles at a safe speed of 70 miles an hour and a 1,000-ft sight distance. Maximum curvature is 2°30′, with return radii for service and access roads to the plant ranging from 35 to 100 ft.

Traffic induced by increased employment has exceeded original estimates. The industry has provided ample parking lots, well distributed in the different plant areas. Expected car use by employees was estimated in 1941 at 2.5 persons per car. A field count completed in April 1943 gave an actual use of 2.6 persons per car entering and leaving. This compares favorably with the state average of 2.13 persons per car.

Primary intersections with South Arlington Street, the Roadside Park approach, and the ramp approach to service roads were channelized to fit estimated volume and direction of traffic flow. Median strips or islands in this channelization are of asphaltic concrete confined by a 4-in. sandstone curb. Islands are set back approximately 2 ft from the projected curb line as protection from weaving vehicles. The present intersection with George Washington Boulevard is temporary and will be relocated and channelized when U.S. 224 is improved east of this intersection.

During Construction of the New Bridge, Traffic Was Maintained on Adjacent Structure

Concrete Sills in Foreground Were Placed to Support Timber Falsework

Very few employees walk or ride bicycles to reach the plant because of its remote location. Recent studies indicate that over 70% of the employees are dependent on private cars and the remainder use buses, which are crowded to capacity. Maintenance parts and the services of mechanics are increasingly difficult to obtain. Approximately 60% of the employees reside 5 miles or more from the plant.

Parking Congestion Eliminated

Personnel managers have reported that a major grievance at some industries is the delay of 30 minutes or more twice a day in getting in or out of parking lots due to congestion. Because of these critical personnel and transportation factors, and the fact that there is little hope of securing additional transportation equipment, it is apparent that efficient access roads to parking lots and service roads providing safe and speedy transportation are a necessary and vital part of defense production today.

The construction of a project like the one under discussion does not present as many unusual features as might be expected. However, in this case the necessity of avoiding interruptions to traffic did call for study. The ordinary highway project, constructed while traffic goes on, involves traffic which to a large extent changes from day to day and thus can be readily shifted without confusion. It was not possible to move traffic about readily in this instance as the greater part was of a local nature interested in access to the plant. When drivers became familiar with one procedure it was difficult to get them to change it without causing some confusion. Relocation of the existing route along plant entrances, and leaving the old pavement in place to remain as a service road, simplified the problem to a certain extent.

Like many other such plants, the Goodyear Aircraft Assembly Plant expanded rapidly during the earlier days of the war. As employment rose considerably over what was expected originally, parking facilities required revision. These changing conditions called for several revisions in plant entrances to meet the demands of traffic. The addition of a parking area east of Kelly Avenue and north of Waterloo Road made it necessary to pave a portion of the Waterloo Road approach during the winter of 1942–1943 so that traffic could be adequately served when maximum employment was reached. Pavement on this section, placed during late January and early February, required the removal of approximately 18 in. of frozen subgrade and replacement before work could proceed. As it was not originally planned to pave

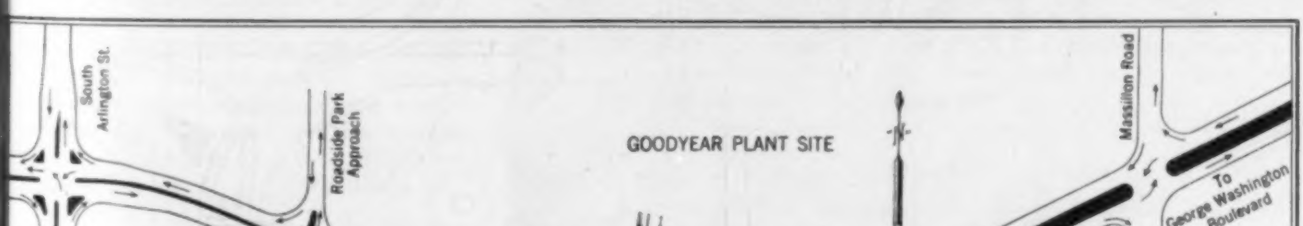
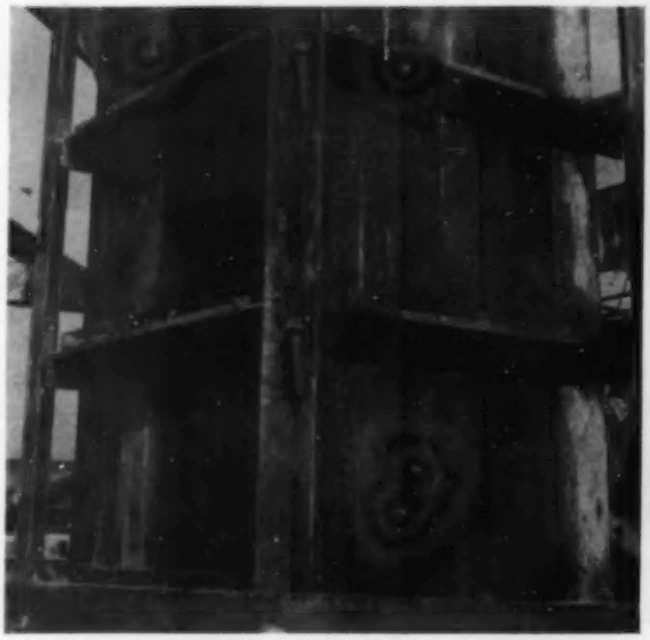


Fig. 1. Access Highway for Goodyear Aircraft Plant



FORMS USED FOR BRIDGE PIERS WERE READILY SET AND REMOVED
Wedge Pins Connect Form Braces; Form Liner Was Used

this section until the following spring, the subgrade had not been covered.

SUPPLEMENTARY ROAD REVISIONS

Cement treated with Vinsol resin was used throughout the project in the pavement concrete to resist the action of salts used extensively in this area in the removal of snow and ice.

Changing traffic requirements caused by expanding plant and parking facilities led to the improvement of three additional sections of highway to act as feeder routes to the project. Arlington Street north from U.S. 224 was the first of the additional access routes to be placed under contract. This was followed recently by Kelly Avenue from the old U.S. 224 to Triplett Boulevard, on which work is now completed. The Triplett Boulevard section from Arlington Street to Kelly Avenue, which has been advertised for bids, and the continuation of U.S. 224 east from George Washington Boulevard to Route 8, which is now under contract, will complete the access roads in this general area.

Relocation of U.S. 224 crossed a section of unstable peat and muck between Stas. 203 and 204 + 72. The plans provided for removal before embankment construction was started. This procedure was used here because the peat was only about 5 ft deep, while the fill section at this point was 35 ft high. Fortunately rock from roadway excavation about 2,000 ft away was available for replacement, so that a sufficient depth of material could be placed to provide a stable foundation.

TWO BRIDGES REQUIRED

Relocation and separation of grades required the construction of two major bridges. One of these, which carries traffic over the Baltimore and Ohio Railroad, has a 64-ft clear span, a reinforced concrete rigid frame, and concrete "U" abutments. It has two 26-ft roadway sections, a 4-ft dividing strip, and two 6-ft walks. The rock-cut railroad section provides an ideal condition for this type of structure. Since it is on a 1°30′ horizontal curve, it has a superelevation of 1.57 ft. Because of wartime restrictions on the use of steel, the contractor worked out a novel timber centering plan which proved satisfactory. He constructed concrete sills on the edges of the rock cut with the top in the same plane as the curve superelevation. These sills were placed on 7.5-ft and 8.5-ft centers. Falsework was then set up using 8-by-8 and 10-by-10 timbers on 5-ft centers for the north part of the deck, which was the low side of the superelevated curve. The railroad track, which was in service during construction, was spanned with 12-by-12 timbers spaced 16 ft in the clear.

Falsework was released on the north side as soon as the required period was ended, and pulled along the inclined concrete sills to the high side of the superelevated curve to permit construction of the other deck section. This method permitted form work to be used again with a minimum of time loss between placement of adjoining deck sections, and also at a minimum cost for adapting the forms. The procedure used was (1) to loosen the forms to secure clearance, (2) move the forms, (3) change the face forms to provide for coping, and (4) wedge up to grade.

The other bridge constructed as a part of this project is a continuous concrete-beam type composed of four spans, consecutively $40^1/_2$, $55^1/_2$, $55^1/_2$, and $40^1/_2$ ft from center to center of bearing. Like the structure just described, it has two 26-ft roadway sections with a 4-ft dividing strip and two 6-ft walks, and is on a 1°30′ curve. It carries traffic from U.S. 224 over the Goodyear industrial track and a ramp providing access and exit to the plant for the thousands of employees engaged in vital war work there. Falsework was set up in such a way that railroad traffic could be maintained.

On the newly constructed project shoulders and slopes are seeded to provide a cover against erosion and to blend them into the landscape. This project is a good example of a very necessary wartime facility which also constitutes a desirable improvement in an important highway system.

Construction was supervised by the Ohio Department of Highways: H. G. Sours, director; W. H. Moore, division engineer; M. D. Shaffer, chief engineer, Bureau of Location and Right of Way; R. O. Nelson, chief engineer of construction; W. S. Hindman, chief engineer, Bureau of Bridges; H. E. Neal, chief engineer, Bureau of Traffic and Safety; W. M. Wardman, division construction engineer; and L. W. Hine, project engineer. The contractor for the project was A. J. Baltes Construction Company, Robert Craig, superintendent.

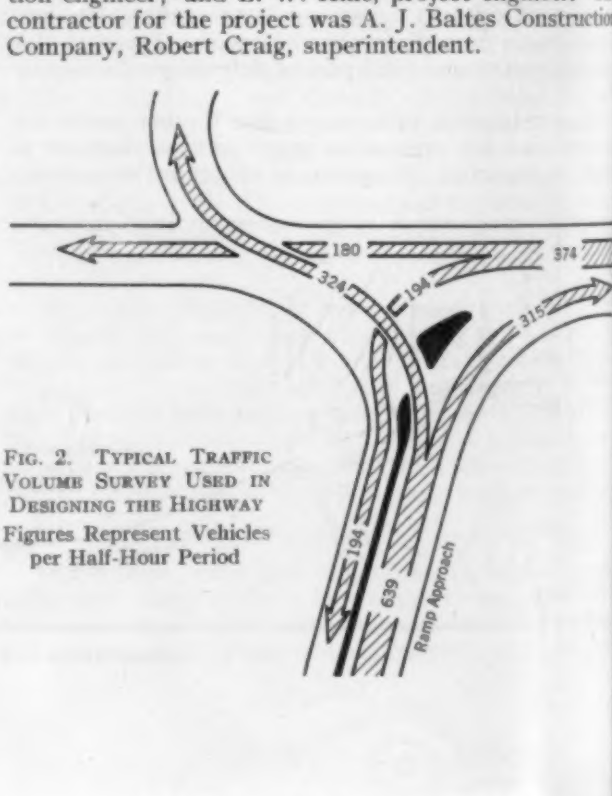


FIG. 2. TYPICAL TRAFFIC VOLUME SURVEY USED IN DESIGNING THE HIGHWAY
Figures Represent Vehicles per Half-Hour Period

Hoisting Equipment Used for Delaware Aqueduct Shafts

By George Spann

Assistant to Chief Engineer, Board of Water Supply, City of New York

The 85-mile Delaware Aqueduct, carrying water from Catskill Mountain streams into New York City's distribution system, has been driven through solid rock, in some places more than a quarter of a mile below the ground surface. Thirty-two shafts provided access to the tunnel. Hoisting operations in these shafts involved some major innovations in equipment and methods. Information obtained from the reports of Board of Water Supply engineers in charge of construction of the aqueduct are contained in this paper by Mr. Spann. Previous articles on the Delaware System appeared in the September 1938 and August 1942 issues.

Construction of the Delaware Aqueduct involved the sinking of 32 shafts ranging in depth from 313 to 1,551 ft. Operations in connection with hoisting in these shafts differed radically in most instances from those generally employed on previous tunnel construction work under the jurisdiction of New York City's Board of Water Supply. Now that construction of the shafts and tunnels of the aqueduct has been practically completed, it is timely to describe the equipment and methods used for hoisting during the principal stages of the work.

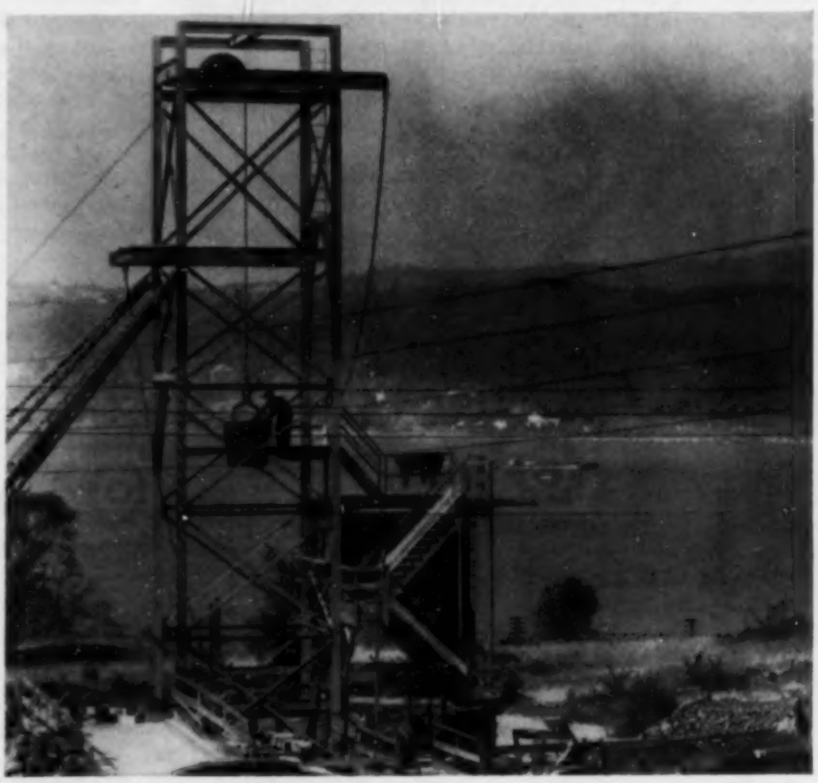
It is specified in each contract in which the sinking of one or more shafts of the Delaware Aqueduct (Fig. 1) is included, that a headframe of approved type and design shall be used in the excavation of each shaft below a depth of 100 ft from the surface of the ground. Shaft sinking with stiff-leg derricks or traveling cranes was therefore limited to depths not exceeding 100 ft. For the initial excavation of shafts prior to the erection of headframes, stiff-leg derricks with hoists operated by steam were used at 7 of the shafts, while traveling cranes, powered by gasoline, diesel or steam engines, or electric motors, were employed at 23 shafts. Of the remaining 2 shafts, Shaft 1A North, at the southerly terminal of the aqueduct, was excavated in 1930 in connection with the work at the same locality for City Tunnel No. 2, and is therefore omitted from the present discussion. Shaft 13 is also considered outside the scope of this article, it having been sunk by unusual methods. During the early portion of shaft excavation, clamshell buckets were generally used for the removal of the earth overlying ledge rock, and shaft muck buckets of the usual type were employed for removal of broken-up rock. Concrete for the shaft linings was lowered in bottom-dump buckets, and shaft buckets were also used for this purpose. The principal features of equipment used during shaft excavation and lining at Shafts 7 to 10, inclusive, are shown in Fig. 2.

Hoisting During Shaft Excavation

After the preliminary shaft excavation had been completed, work in the shaft was suspended pending the erection of a headframe over the top of the shaft, the construction of a hoist house, and the installation of the hoist with its motor and appurtenances. The headframes were towers of structural steel which varied in height from 35 to 90 ft, the majority being about 60 ft high. At the top of each tower, centered over the shaft, was a large sheave for the passage of the cable from the hoist into the shaft. The cables were stranded steel, nontwisting, $^7/_8$ in. or 1 in. in diameter. Except at a few of the shafts where timber chutes conveyed the muck directly from the muck buckets into waiting trucks, a muck bin or hopper was constructed integral with, or at one side of, the headframe.

All the hoists regularly employed in this portion of the work were operated by electric motors of from 75 to 250 hp. The hoists were located in hoist houses at the surface of the ground. Safety appliances installed in connection with the operation of the hoists included dial indicators, overwind and speed controls, and signaling systems.

The openings in the platforms over the shafts were provided with counterweighted doors so that the shaft could be entirely closed, thereby lessening the chance of objects from loaded buckets or from the surface falling on men in the shaft. At a number of the shafts "Billy blocks," or frames riding on cable guides, were employed to guide the buckets in their travel at the upper



Headframe and Muck Hopper Used During Construction of Shaft 6

HEADFRAME AND MUCK BIN FOR TUNNEL CONSTRUCTION AT SHAFT 5A
Skip Is in Dumping Position Over Bin

HEADFRAMES AND MUCK BINS USED DURING TUNNEL CONSTRUCTION AT SHAFTS 19
Hoist Houses Above, Operators' Houses Below

portion of the shaft. Bull chains or cables were generally used for bringing buckets into position to dump muck or load men or materials. For the removal of muck, regular muck buckets of from 1 to $2^1/_2$-cu yd capacity were provided. For lowering the concrete for the shaft lining, bottom-dump buckets of from 1 to $2^1/_2$-cu yd capacity were generally employed.

Except at Shafts 1, 11, 12, 13A, and 14, the headframes just described were not used as parts of the regular hoisting plant for tunnel-driving operations. This was principally because the work of sinking and lining the shafts and excavating the adjacent short tunnel spurs was included in contracts separate from those for the construction of the main part of the tunnel. In the exceptional cases cited, all work in the shafts and tunnel was combined in the same contract, and in these instances the headframes first installed were used until all tunnel work was completed. At Shafts 15 and 16, where all shaft and tunnel work was also included in one contract, the shaft-sinking equipment, including the headframes, was nevertheless removed and supplanted by the equipment used for tunnel excavation. For excavating and lining these shafts, however, the general contractor employed one of the contractors who had previously sunk and lined four other shafts of the aqueduct. The latter removed his plant after the short tunnel spurs had been excavated, and the general contractor then erected his own equipment for driving the tunnel.

In addition to the plant operated for the excavation of the shafts, auxiliary hoisting equipment was maintained at the shaft areas for use at the surface and during any possible emergency in the shaft when the regular equipment might be out of order. In most cases, such emergency hoists comprised derricks or cranes that had been previously used in excavating the shafts for the first 100 ft of their depth. At a few of the shafts an emergency hoist powered by a self-starting gasoline engine was installed in a separate hoist house and provided with independent cable and sheave working in the headframe. These hoists were also used for lowering pumps and other equipment.

Lengths of tunnel, varying from 6,425 to 28,933 ft, were driven from 26 of the 32 shafts of the Delaware Aqueduct. The headframes employed during tunnel excavation were towers built up of structural steel members extending in some instances to a height of about 150 ft above the top of the shaft. At the 16 shafts north of Shaft 15 through which tunnel excavation was carried on, and also at Shaft 17 Downtake, the hoists were located in hoist houses at the surface of the ground, from about 80 to 200 ft from the base of the headframe. At Shafts 4 and 5, for example, each headframe was a very substantial steel structure consisting of a rectangular steel tower 22 ft by 32 ft in plan at its base and 22 ft

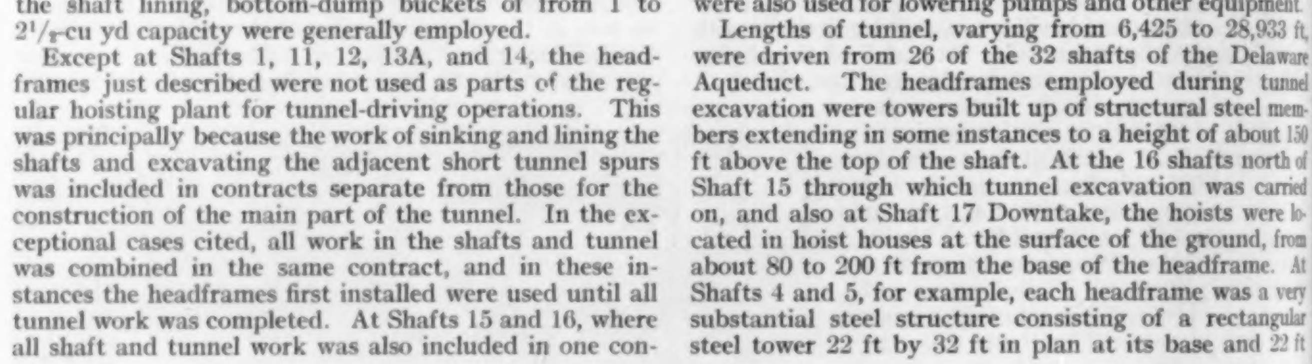


FIG. 1. PROFILE OF THE DELAWARE AQUEDUCT

by 18 ft $1^5/_8$ in. at the top, made up of 12-in. columns, 40 lb to 65 lb per ft, with 10-in. and 12-in. cross beams spaced about 11 ft apart vertically, with diagonal angle bracing between them.

The tower was 140 ft in height with the center of the two sheaves 125 ft above ground. The additional 15 ft in height above the sheaves was provided for the installation of an overhead hoist on a cantilever arm for replacing the sheaves. This tower was braced on the side toward the hoist with two back legs made of 12-in. 65-lb and 12-in. 99-lb members latticed together and to the tower with horizontal and diagonal bracing. The back legs started from the tower proper at sheave elevation and were anchored at their lower ends by heavy concrete piers. These piers were located 73 ft back from the base of the tower proper, making the area of the headframe at ground level 32 by 95 ft. The two sheaves, which had a 10-ft 8-in. rope diameter, were each supported by a pair of heavy cross members. The headframe structure was set at an angle of 24° with the tunnel line.

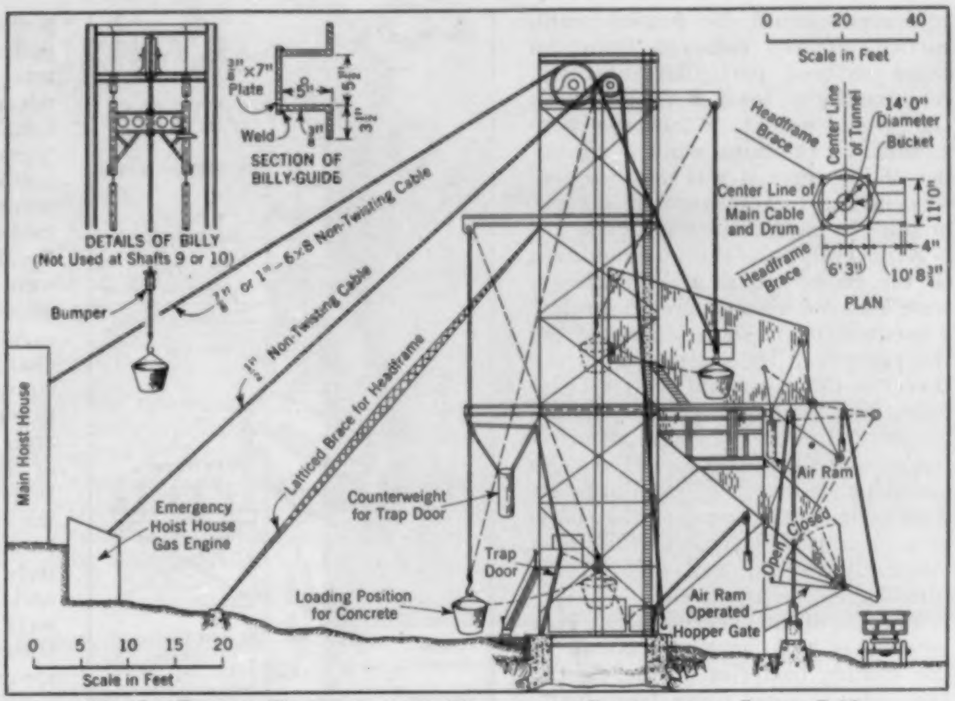


FIG. 2. TYPICAL HEADFRAME AND HOPPER FOR CONSTRUCTING SHAFTS 7–10

At the nine other shafts used for regular tunnel driving, the hoists were installed in hoist houses at the tops of the headframes over the shafts. An example of a headframe with the hoist and hoist house at its top is that used at Shafts 22 and 23 (Fig. 3).

Attached to each headframe was a muck bin or hopper (there were two at each of Shafts 7 and 8) for receiving the muck as it was dumped from the skips or cars after being brought up from the tunnel. Except at four of the shafts, where small hoppers were provided for breaking the fall of the muck from the skip to the truck rather than to furnish storage capacity, each muck bin held from 50 to 250 cu yd, those of 100 and 150-cu yd capacity being most common. The following is a summation of the arrangement of cages and skips in the shaft:

Single cage balanced by a counterweight, at five shafts: Shafts 13A, 14, 17 Uptake, 22, and 23

Two cages in counterbalance, at one shaft: Shaft 1

One cage-skip combination balanced by a counterweight, at two shafts: Shafts 4 and 5

One cage balanced by a skip, at five shafts: Shafts 5A, 6, 17 Downtake, 19 Uptake, and 19 Downtake

One cage balanced by a counterweight, and one skip balanced by a counterweight, cage and skip operated independently, at four shafts: Shafts 15, 16, 20, and 21

One cage-skip combination balanced by another cage-skip combination, at nine shafts: Shafts 2, 2A, 3, 7, 8, 9 Downtake, 10 Uptake, 11, and 12

One or two cages for raising and lowering men and materials were employed at each shaft equipped and used for regular tunnel-driving operations. In 20 of the 26 shafts so equipped, one or two skips for hoisting tunnel muck out of the shaft were also employed. There were many variations in the arrangement, operation, and size of the cages, skips, or cage-skip combinations, the selection in any particular case having been influenced by such factors as the size and depth of the shaft, and the number, size, and length of the tunnel headings to be driven from that shaft.

At Shafts 7 and 8, the hoist engine had a double drum. Each dum with its cage-skip combination could be operated in counterbalance, joined with the other cage, or separately. Normal operation was in counterbalance.

Skips for the removal of muck from the tunnel were installed and used at all but 6 of the 26 shafts equipped for tunnel driving. In these 6 shafts it was necessary to bring the loaded muck cars to the surface. At Shaft 1, the muck cage accommodated a 5-cu yd end-dump muck car, which was automatically dumped into the muck hopper at the top of the shaft without removing the car from the cage, this being accomplished by the tilting of the cage body as it followed a curved track in the headframe. At Shafts 13A and 14, each loaded muck car was brought up on the cage to the level of the dumping platform, where it was pushed by means of a rack-and-pinion type of car-pusher onto a rotary car dumper which emptied it into the muck bin. At Shaft 17 Uptake, the loaded side-dump muck cars were brought up on the cage to the top landing, hauled from the cage with a small tugger hoist to a tipple at the top of the storage bin and dumped. At shafts 22 and 23 (Fig. 3) side-dump muck cars were emptied without being removed from the cage, the latter being equipped with a pneumatic ram which tilted the body of the muck car and dumped its contents directly into a chute leading to the muck hopper.

At each shaft where one or two skips were used for raising muck from the tunnel, skip pits were excavated at the foot of the shaft below the tunnel invert and lined with concrete. The muck was then dumped directly from the muck car into the skip as it rested in the pit. Cars were either of the side-dump or non-dumping type, the latter being emptied by overturning in a rotary dumper. The loaded skip was raised until it reached a position in the headframe where the body of the skip was automatically tilted sufficiently to dump its contents into the muck bin.

At many of the shafts, the cages were sufficiently large so that drill steel, pipe, rail, structural steel members for roof support, and other long materials and pieces of

equipment could be loaded onto, carried on, and removed from the cages without particular difficulty. At some shafts, some of the materials that would not fit on the cages were handled by the skips, while in a number of instances it was necessary to suspend long materials under the cages or skips by means of cable slings.

At several of the shafts, in addition to the main hoists, material hoists were installed which operated through a hoistway in the shaft separate from the portion of the shaft used for the travel of the cages and skips. These hoists permitted the lowering of materials and equipment without interfering with the operation of the cages and skips. Emergency gasoline hoists were provided at some of the shafts as a precaution in case of failure of electric power so that men in the tunnel could be removed.

The size of the cages influenced the location of the charging stations for the storage batteries of the electric locomotives, some cages being sufficiently large to accommodate the locomotives and permit their being brought to the surface without difficulty, while in other cases where the cage was too small for the locomotive, the batteries were recharged in the tunnel. At some shafts, however, the batteries were removed from the locomotives and brought to the surface to be recharged while the locomotives were serviced in the tunnel.

SAFETY DEVICES

Operation of the cage hoists was governed by modern automatic control devices that incorporated safety features functioning independently of the will of the operator. These controls prevented cage speeds in excess of the predetermined limit, reduced the speed of the cage as it approached a landing, prevented over-travel in either direction, and stopped the cage in the event of failure of current or failure of a vital part of the equipment. At some of the shafts, switches were installed at top and bottom to enable the signalman to cut off the hoist power in an emergency. Dials and automatic bell signals indicated to the hoist runner the position of the cage in the shaft. Inter-communication between shaft bottom, shaft top, and hoist house was had by means of bell signals, teletalk, and telephone. Careful maintenance and regular inspections provided additional insurance against failure of the hoisting equipment and controls.

The cages were equipped with two or more sets of safety dogs which gripped the guides in case of cable failure. Normally, the dogs were held in position away from the guides by the pull of the cable on which the cage was suspended. When this pull was released for any reason, powerful springs actuated the dogs, causing them to grip the guides and prevent further movement of the cage. In accordance with the specifications of each tunnel contract, the operation of the dogs was tested before the cages were placed in service and at least once every three months thereafter.

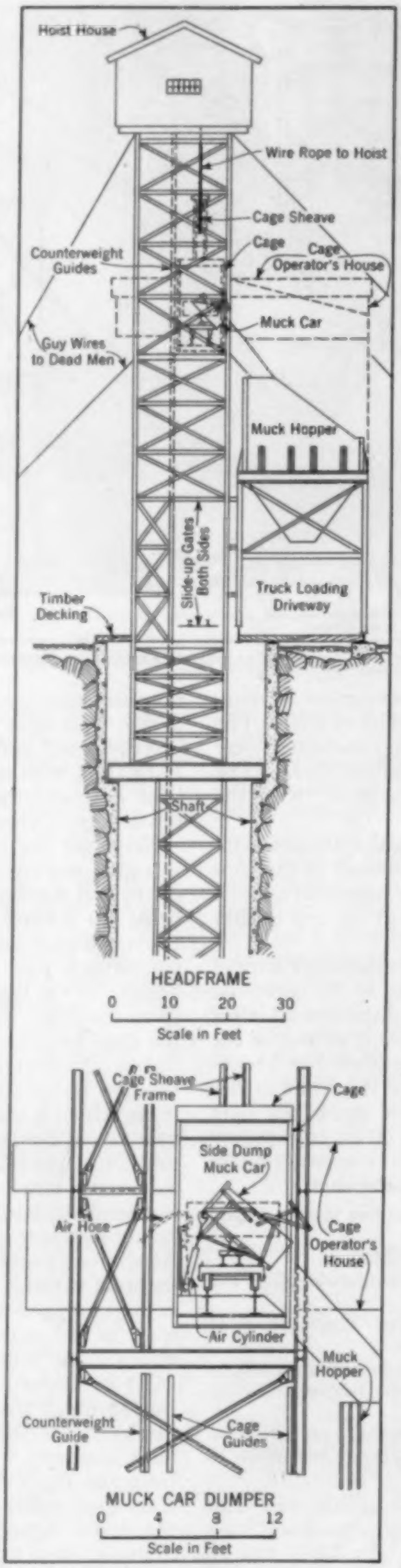


Fig. 3. Cross Section of Headframe and Muck-Car Dumper Used for Tunnel Construction, at Shafts 22 and 23

At many of the shafts, little or no change was made in the hoisting equipment during the major operations of placing and grouting the concrete lining of the tunnel. The use of the equipment during these operations was much less than it had been throughout the period of driving the tunnel headings. In the shafts pipes were installed through which cement and dry aggregates or mixed concrete were dropped. At some of the shafts, these pipes, or the hoppers at their lower ends, utilized portions of the space formerly used by the cages or skips and in these cases certain changes were necessary. For example, at Shaft 1, the use of one cage was discontinued, the hoisting cable being shortened so that the cage would not interfere with the hopper at the foot of the shaft. At Shafts 15 and 16, the muck skip was removed so that two pipes could be hung in the skip well.

It was general practice during the placing of the tunnel lining to leave a section of the tunnel unlined at, and immediately adjacent to, the foot of the shaft until all other work in the tunnel had been completed. By this means transportation up and down the shaft suffered a minimum of interference from other operations until the very last stages of the tunnel work.

The final work in the shafts varied greatly, depending upon the purpose of the shaft. In any case, it was necessary to remove from the shafts the cages and skips, guides and guide supports, service lines, ventilation pipes, and escape ladderways that had been installed and maintained during tunnel construction. The removal of this equipment, together with the construction work that followed to complete the shafts, required the use of hoisting equipment. Such equipment comprised portions of the equipment previously employed, altered to suit the requirements at the particular locality and supplemented by such additional equipment as was needed.

Further details on hoisting operations may be found in the November 1943 *Delaware Water Supply News*, from which the present paper has been condensed.

High-Level Highway Bridge Spans Thames River

II. Design of Connecticut Structure and Approaches

By L. G. Sumner, M. Am. Soc. C.E.

Engineer of Bridges and Structures, Connecticut State Highway Department, Hartford, Conn.

To carry highway traffic between New London and Groton, Conn., a high-level cantilever bridge nearly 6,000 ft long was completed in 1943. Its four traffic lanes are expected to provide needed capacity for the next forty years. The design of the bridge and its appurtenances is described by Mr. Sumner in this article, which is the second of a series on this bridge that began in the March issue.

Trusses for Approach Spans Were Erected in Four Units, Each Continuous Over Three Spans

Location of the new Thames River Highway Bridge cuts across the irregular street pattern of New London, Conn., and passes over the main line and yard facilities of the Central Vermont Railway to the river bank 2,600 ft away. Next comes the river crossing proper, about 2,000 ft from bank to bank. This joins the approach work in Groton, about 1,300 ft long, where the location is carried over route Conn. 12 and the tracks of the New York, New Haven, and Hartford Railroad. The total length is thus 5,900 ft. Required areas in New London were largely occupied by rather low-type housing which offered no particular obstacle to the purchase of right of way. It was possible to avoid conflict with railroad facilities, and the location in Groton was largely across unoccupied land. The river crossing offered no obstacles to pier location other than those imposed by channel location, clearance requirements, and the character of foundation material.

Experience with the existing highway bridge clearly demonstrated the inadequacy of a two-lane roadway for the structure. Modern trends favored the adoption of the "dual" roadway type with physical separation between opposing traffic streams. Traffic counts indicated a daily average of about 14,000 vehicles and a maximum daily count of something less than 19,000. Records of the past ten years gave a fairly consistent annual increase in traffic volume of about 4%. As the capacity of a four-lane roadway structure may be taken conservatively at 50,000 vehicles a day, this bridge is expected to serve the maximum daily traffic for about forty years.

High curbs were considered essential as a safety measure. As motorists will not drive close to such barriers, it

Piers Were Erected on Steel Piling Within Sheet Steel Cofferdams

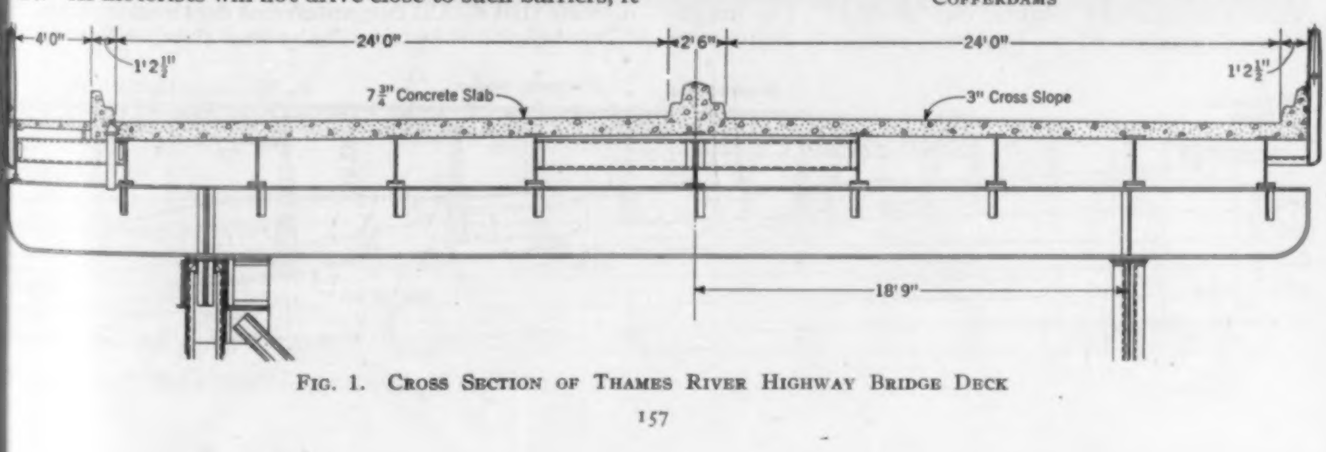


Fig. 1. Cross Section of Thames River Highway Bridge Deck

CENTER SPAN NEARING COMPLETION
Railroad and Highway Bridges in Background

was decided to adopt a 12-ft lane width. The width of the center mall or separating strip is 2 ft 6 in., the minimum for practical construction. Because it was felt that a structure nearly 6,000 ft long would offer few attractions to the pedestrian, sidewalk facilities were reduced to a minimum of one 4-ft walk on the downstream side of the bridge. The resulting cross section is shown in Fig. 1. The decision to locate the surface of the sidewalk at approximately roadway level instead of at the top of the curb made it possible to keep the railing lower, thereby giving the motorist an increased chance to enjoy the view as he drives over the high structure.

WIND LOADS CONSIDERED

In general, the standard specifications of the American Association of State Highway Officials governed the design of the structure, with certain modifications. For steel bearing piles, the 14-in. section weighing 73 and 89 lb per ft was decided on. The maximum pile load for dead plus live load was taken at 55 tons per pile; and that for dead, live, and wind load, the maximum for extreme corner piles, was increased to 80 tons per pile. The transverse wind load, taken on areas computed as in A.A.S.H.O. specifications, including exposed areas of piers, was taken at 30 lb per sq ft plus 200 lb per ft of bridge for wind on live load. Longitudinal wind loads, per foot of bridge, were taken at 60% of the transverse wind load for lengths up to 300 ft, 45% for the next 700 ft, and 30% for lengths above 1,000 ft. Wind load on vehicles on the bridge was not included in computing longitudinal wind loads.

Several studies were made of the layout of the approach viaducts, particularly on the New London side, before a satisfactory solution was obtained. The irregular street pattern did not lend itself readily to uniformity in span lengths, and skew spans were considered undesirable because of the resulting complication in detail. Piers placed a safe distance back of street lines and square to the center line would result in span lengths too great for girder construction, which was indicated as the most satisfactory type. The scheme finally adopted was to locate the main piers as necessary to clear the streets and then reduce the span lengths to practical limits by introducing single columns. These columns were located as necessary to give clearance and to provide as much symmetry as possible. Vertical loads only are taken by these single columns, as the bracing system is designed to carry all lateral forces through to the main piers.

The resulting layout consists of a series of two-span units, continuous over three supports. The total length of these units varies from about 179 to 272 ft, and that of individual spans from about 119 to 135 ft. With this arrangement it was found possible to detail all girders, except those for the 272-ft spans, with 100-in. webs and 8 by 8-in. flange angles, and to maintain a nearly uniform panel length of about 25 ft. For the 272-ft spans, 108-in. webs were used.

Where the location crosses the facilities of the Central Vermont Railway, the possibilities of pier location were so strictly limited as to require much longer spans and the use of a truss-type superstructure. Also the height of piers at this point had increased to such an extent as to render the shorter girder spans both unsightly and uneconomical. Therefore, the change to truss construction was made at a point just west of the Central Vermont Railway property, and the exact arrangement of spans remained contingent upon the decision as to the type of structure over the channel. At the Groton approach, there were fewer obstacles to pier location. It was therefore found possible to employ layouts of truss spans symmetrical about the center line of the channel span, and to have a relatively short length of girder spans carrying the structure to the east abutment.

STEEL BEARING PILES USED

The problem presented by the river crossing was mainly one of economical pier location. The borings indicate that rock is encountered at depths of from 100 to 150 ft below low water and also that the rock has a well-

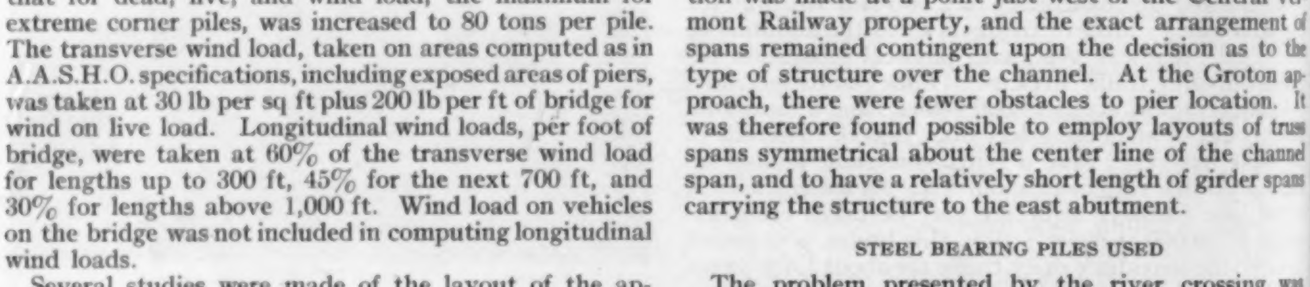


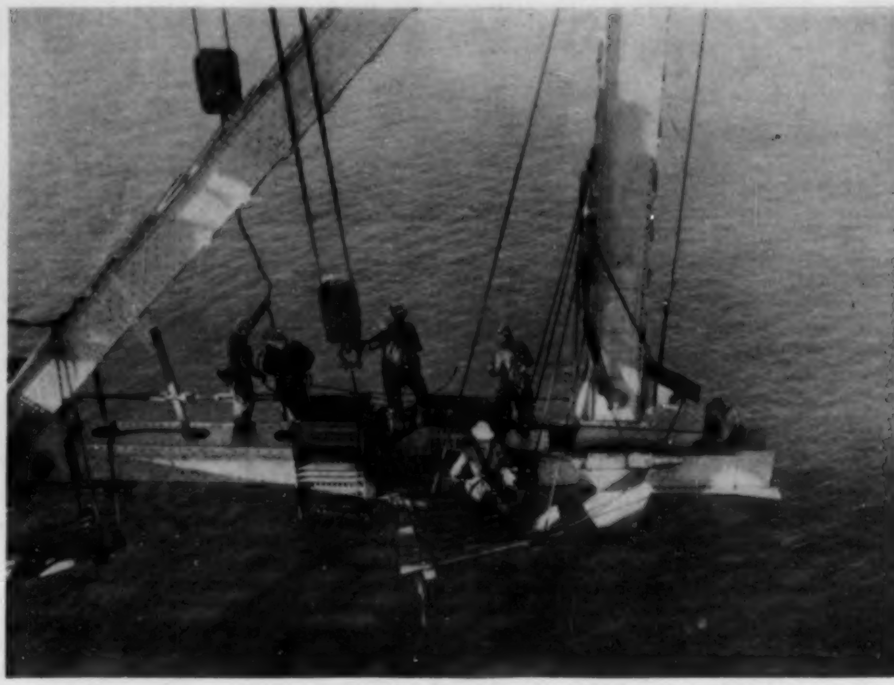
FIG. 2 PROFILE OF THAMES RIVER HIGHWAY BRIDGE

defined slope from the banks toward the center of the stream. First conceptions of the project had been based on founding the river piers on rock, but investigations showed this to be too costly. Therefore steel bearing piles were driven to rock as a means of supporting these piers.

Immediately below the stream bed the material is a fine silt offering but little lateral support to piles, but immediately above the rock, the material is of more substantial character. Pile driving tests, including horizontal load tests, carried out before designs were completed, indicated satisfactory resistances for piles penetrating these lower strata so that good anchorage of pile tips driven to rock was assured. At their upper ends the piles are firmly held by deep embedment in the tremie-poured concrete of the pier bases. A liberal use of batter piles provides resistance against lateral displacement, and as a further measure of protection against lateral forces, the pier bases are surrounded with steel sheet piling driven 10 to 20 ft below the bottom of the pier footing and left in place.

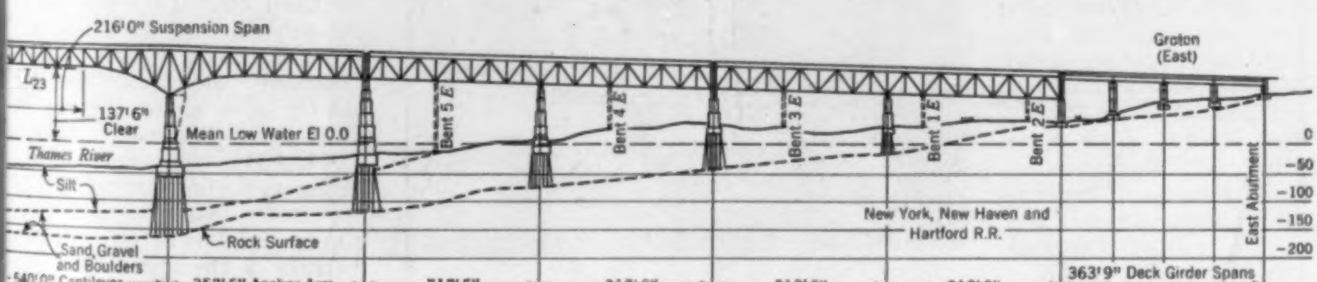
Based upon the use of such typical piers, the next step was the selection of the type and length of the span over the channel, where War Department clearance requirements were 200 ft horizontally and 135 ft vertically above mean high water. Because of the expense of providing falsework, conditions at the site indicated the desirability of cantilever erection. This could be obtained most readily by adopting either the cantilever or the continuous type. The former was selected for the channel span, primarily because of the foundations, which were not considered to justify the use of continuous spans.

Numerous layouts of spans were tried and finally narrowed down to the two involving the use of four and six river piers, respectively. The first scheme had a main span of 880 ft with 440-ft anchor spans,



Jack Used on Main-Span Cantilever to Make Closure with Suspended Span

Steel of Center Span Was Balanced on River Piers During Erection



...luding Approaches and Foundation Conditions

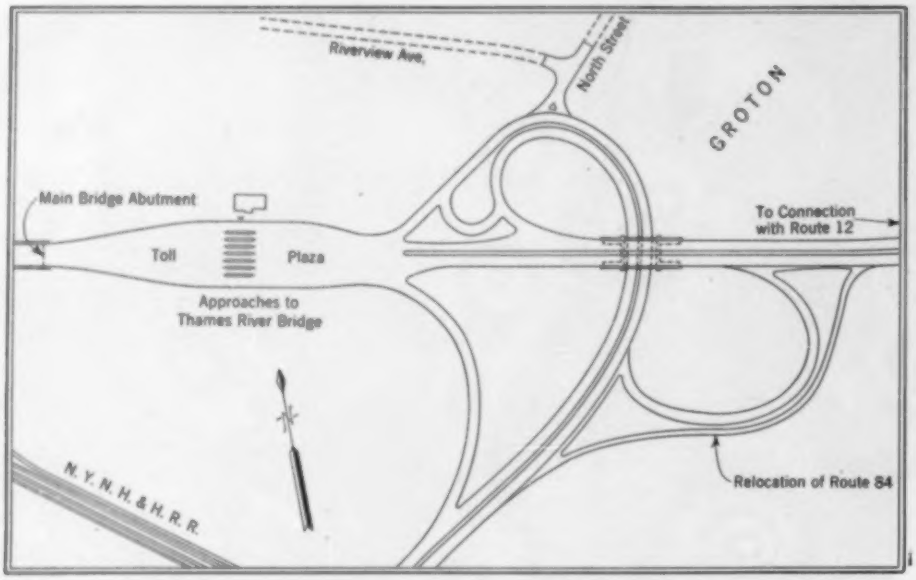


FIG. 3. GROTON APPROACH AND TOLL PLAZA

flanked on each side by three simple spans of 330 ft each. An uneconomical distribution of cost between substructure and superstructure pointed to the desirability of shorter spans and resulted in the second layout (Fig. 2). In this scheme the main span is 540 ft, made up of 162-ft cantilever arms and a 216-ft suspended span. The anchor spans are 351 ft each, followed by four spans each of 311 ft; these latter are built as two-span, continuous units. The entire arrangement of the truss spans is symmetrical about the center line of the channel.

This arrangement was felt to be the most economical possible under the conditions and was adopted. Appreciable economies over the longer-span layout were established. Further shortening of the main span was considered unwise because of the increased depth to rock as the channel is approached.

Location of the toll plaza presented no particular difficulties. From the first inception of the project as a toll facility, it was necessary to select a tentative site for this plaza. Fortunately a satisfactory location was readily discovered on unoccupied land immediately east of the east abutment in Groton (Fig. 3). Ten toll lanes having an estimated capacity of 5,000 vehicles an hour are provided, thus insuring that the collection facilities will be sufficient to develop the full capacity of the operating lanes on the bridge. Lanes through the toll booths are 10 ft wide and are separated by 5-ft islands on which the booths are placed. These are so arranged as to permit collection of tolls from the left hand, or driver's side, in all lanes. An administration building providing office space for the bridge manager, clerks, and accountants, as well as locker and rest-room facilities for toll collectors, completes the layout of the toll plaza.

As traffic studies had indicated that at least 75% of the anticipated traffic would be of local origin, the problem of planning convenient means of access to existing streets became of primary importance. Origin and destination studies served to show the distribution of this traffic to various areas adjacent to the structure as well as the number of vehicles destined for more distant points.

It was shown that in New London local traffic from the north would reach the bridge by way of Williams Street, and from the south and southwest it would be divided between Main, Huntington, and Williams streets. The final solution for the access facilities at this end of the structure combines certain features of the clover-leaf intersection with those of the traffic circle (Fig. 4).

In this scheme, the emphasis is placed on Williams Street as the best means of reaching and leaving the bridge, although vehicles may use the Main or Huntington street routes without too great difficulty if they elect to do so. Williams Street was selected as the main artery because it is best suited by both location and physical character to handle an increased volume of traffic, whereas both Main and Huntington streets, although leading more directly to the business center of the city, are narrow and congested by local traffic.

The features of the Groton approach include, first a connection to the Borough of Groton to serve the 4,000 vehicles daily originating there, and second the provision of proper connections to both routes U.S. 1 and Conn. 84. This was later extended to include a new connection to route Conn. 12, which was extensively relocated for reasons not connected with the bridge project, and now connects directly with U. S. 1 and the bridge approach to the east of the toll plaza. Grade separations and ramps eliminating left turns are provided at all intersections.

Bids for the substructure and superstructure of the Thames River Bridge were received on December 23, 1940. The A. I. Savin Construction Company of Hartford offered the low bid on the substructure at $1,487,400, and the Harris Structural Steel Company submitted the low bid on the superstructure at $2,255,000. This made a total of $3,742,400 as compared with the engineers' preliminary estimate of $3,750,000. Numerous additional contracts covering various features of the approaches were awarded. Accounts of the construction will appear later.

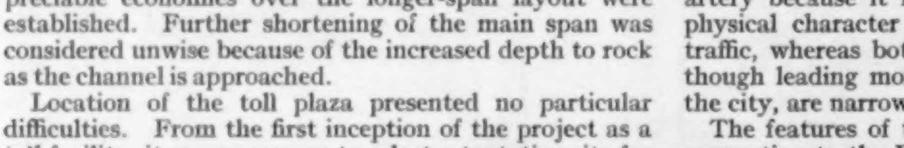


FIG. 4. NEW LONDON APPROACH TO THAMES RIVER HIGHWAY BRIDGE

A Gravel-Surfaced Section of the Pan American Highway in San Salvador

A Timber Truss Bridge Crossing the Melendrez River in Guatemala

Commercial Use of Inter-American Highway

From Paper Presented Before Highway Division at Society's Los Angeles Convention

By B. W. Belyea

Acting Traffic Consultant to the Coordinator of Inter-American Affairs, Washington, D.C.

In the latter part of April 1943, the Coordinator of Inter-American Affairs dispatched a survey party to go over that section of the Pan American Highway which extends through the five Central American republics, known as the Inter-American Highway. It was the duty of this party to determine, as nearly as possible, the adaptability of the highway, when completed, to commercial use, and to work out an estimate of its potential tonnage capacity for the movement of passengers and property. The principal duty of this party was to investigate current trucking problems in the Central American countries with a view to indicating various measures that might be taken to improve the volume of trucking during wartime through better distribution of tires, gasoline, and spare parts, and through better maintenance procedures.

Before the War Department became interested in the construction of the Inter-American Highway (see "Army Reports on Pan American Highway," by Col. E. C. Kelton and Maj. H. E. Spickard, Civil Engineering November 1943), the route had been planned as a long-range program, to be under the direction of the Public Roads Administration, with the various countries participating in the cost (see "Development of the Inter-American Highway," by E. W. James, Civil Engineering, January 1944).

In July 1942, instructions were issued authorizing construction of the highway. The original directive for the construction was predicated on the movement of military equipment and supplies under the supervision of the armed forces. Originally, the road was ordered built to a minimum width of 16 ft, with turnouts, or passing strips, every 4 miles. These strips were to be 4,500 ft in length. The design itself shows that our government had intended to use it only as a one-way road, over which all traffic would be strictly controlled and would move mostly in convoys. The convoy system is probably the most satisfactory one for a military movement, but it has never proved satisfactory or economical for commercial purposes. It is evident that the stretch of pioneer road connecting the standard Pan American Highway, according to original design, would be of very little use as a commercial artery, since the conventional $1^1/_2$-ton truck on dual rear tires has an overall width of 7 ft 6 in., and practically all freight equipment in this country carries bed widths of 8 ft. Even if the beds were cut down to the exact outside width of the tires, they could only be narrowed 6 in., and two trucks could not pass on the highway unless a series of turnouts were provided.

During Construction Tropical Rains Created Impassable Quagmires

It is understood, however, that the specification of a 16-ft minimum width has resulted in a road practically 20 ft wide. If this width is held to along the entire route, or if the road is brought to this width through maintenance, it will be satisfactory for commercial use.

When completed, the pioneer part of the high-

THE HIGHWAY ON CONORA HILL, GUATEMALA

way will conform to a standard whereby grades will in general not exceed 7% and the curves will seldom have a radius of less than 200 ft. In the main, the alinement is very good. There are a few cases, however, where the project has used existing highways built by the various republics. In these cases, short grades are encountered that have a maximum of 13%, and some of the curves are considerably sharper than the standard previously mentioned. These cases are very few, however. It is my belief that there is nothing that will cause unusual difficulties in trucking operations, other than the climate. The country through which the road passes is almost entirely tropical, and in some districts the rainfall is tremendous. As the road will be surfaced only with gravel, there may be a tendency for trucks to get bogged down, or at least to tear up the road badly during the wet season. Bridges are being constructed to 15-H design, which should be adequate for any truck movement in the near future.

The highway as constructed should prove a tremendous boon in the commercial development of all the countries through which it passes. Now that a through highway is in existence, a system of feeder roads can be built to open up the interior of the country. The role which a main thoroughfare plays in encouraging the construction of feeder roads was well demonstrated in El Salvador. This country—incidentally, the smallest in the Western Hemisphere—completed in the late 20's a penetration macadam highway its entire length, with the exception of the last 40 miles from San Miguel to the border of Honduras. Since this highway was opened, many supplementary roads have been built to tap the rich interior, and the traveler cannot help but be impressed by the agricultural development of this republic.

UNIFIED CONTROL RECOMMENDED

Inasmuch as the highway, in its length of 1,500 miles, passes completely through four and practically through five republics, each with its own form of government and with separate and conflicting laws regulating the movement of motor vehicles, it was recommended that the operation of the highway be placed in the hands of a control commission which would be similar to the toll road and toll bridge authorities of this country; and that this commission have supervisory jurisdiction over the entire length of the highway, so that the laws governing the movement of freight and passengers and regulations as to entries, collection of duties, and so forth, would be uniform.

Colonel Kelton, Director of the Pan American Highway, is seeking to interest the governments of the five countries in the maintenance of the highway when completed, since maintenance will play a very vital part in determining whether or not the highway will be usable commercially, and is essential to protect the investment. Every effort has been made in the construction to provide adequate drainage. In most cases, the present highways of these republics are not properly maintained and are deteriorating rapidly even under the extremely light tonnage moving over them at this time.

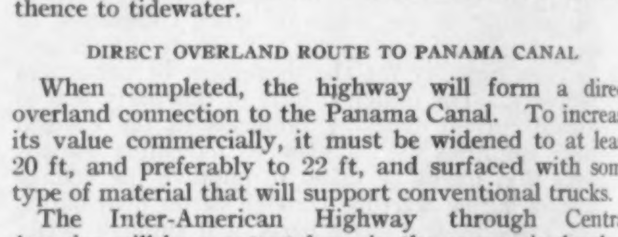
The Inter-American Highway passes through what is probably some of the most fertile land on the face of the earth. Potentialities for agricultural production are almost unlimited. Development of these republics will not take place overnight, but there are many hopeful beginnings in the form of health and sanitation programs, through education, increased local food production, etc. Every assistance should be offered to these countries to undertake positive programs both official and private in cooperation with the United States for their own economic benefit and for the benefit of the Western Hemisphere as a whole.

The highway passes through many miles of the most beautiful hardwood timber imaginable. This alone is of tremendous value, and a great tonnage could be exported. All logging, however, is accomplished by the use of oxen, and the sawmills are not equipped to cut over 14-ft lengths. All this is due, of course, to the limited means of transportation. The road, when completed, will give the republics every opportunity to put under cultivation thousands of acres and to utilize mineral deposits now inaccessible. Certain feeder roads are already planned to lead to the highway and thence to tidewater.

DIRECT OVERLAND ROUTE TO PANAMA CANAL

When completed, the highway will form a direct overland connection to the Panama Canal. To increase its value commercially, it must be widened to at least 20 ft, and preferably to 22 ft, and surfaced with some type of material that will support conventional trucks.

The Inter-American Highway through Central America will be a potent force in the economic development of these countries, and the role of the United States in collaborating with them in its construction is truly an outstanding example of the good-neighbor policy.



TIMBER BRIDGE PROVIDES ONE-WAY STREAM CROSSING

Engineers' Notebook

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

Corroded Sections of Steel Bridges Repaired by Welding

By A. M. Knowles

Engineer of Structures, Erie Railroad Company, Cleveland, Ohio

SALT brine which drips from refrigerated railway freight cars is very destructive to the steel of railroad structures, particularly bridges. It spouts out from the cars in such a way that it does not touch the steel underframe and running gear of the cars but falls about one foot outside of the track rails. It is blown and spattered on the rails and their fastenings, but

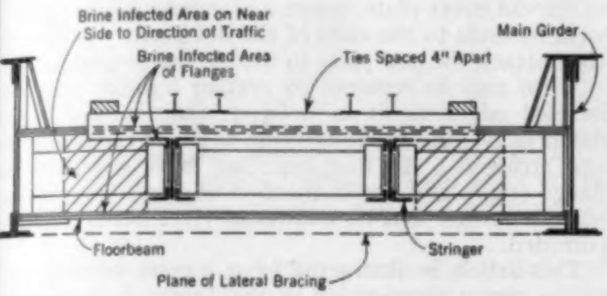


Fig. 1. Typical Section Through a Plate-Girder Bridge

greater damage is done to the steelwork of open-floor railroad bridges (Fig. 1).

Although extensive research and experimentation with many types of paint and other protective coatings have been made, nothing has been found that is effective for a reasonable time against the destructiveness of the brine. Therefore the loss in section of bridge members, or of parts of bridge members, such as stringers, floor beams, deck girders, trusses and even lateral bracing, becomes in time so great as to materially reduce their strength.

Any repairs to the corroded and deteriorated bridge members must be carried out with as little interruption to railroad traffic as possible. In the past it has been the custom to replace deteriorated members, or parts of members, of a bridge. This sometimes required extensive falsework, and in all cases there were many rivets to be cut out and reriveted after the new parts were installed. When complete and reliable records of shop details were available, the new members or parts of members could be prefabricated, and a fairly good fit would result. Sometimes, however, the records were unreliable or non-existent. In such cases two methods might be used. According to one method, the repair steel was brought to the job unpunched and placed on the old parts, which were retained as a template until the holes could be drilled in the new parts to match. The other method was to take field measurements of the rivets spacing to permit prefabrication of new parts, which frequently resulted in much mismatching of holes.

Stringers usually consist of I-beams or a web plate and two flange angles, top and bottom, with or without cover plates. The effect of brine extends over the upper surfaces and is most severe on the outer edges of the top flanges. When there are no cover plates, the width of the flanges is materially reduced and the edges become wedge shaped and scalloped. Where there are cover plates, the deterioration affects both the plates and the outer edges of the angles. Frequently an excessive thickness of rust is built up between the cover plates and the angles, and extends to the rivets connecting them. In such cases the rivet holes are frequently enlarged, and the heads and shanks of the rivets are reduced so as to become ineffective.

When stringers have no cover plates, there are two common ways of making repairs using rivets. First (Fig. 2*a*) rivet holes are drilled in the horizontal legs of the old angles to match the prepunched plates, which are then riveted to the angles. This can be done only if the reduction in the angles, both on upper surfaces and edges, is not too great. Tight rivets cannot be driven when the angle surface in contact with the plates is pitted very irregularly. The width of the remaining flange angles must be sufficient to provide adequate edge distance for the rivets. Usually the track rails are over the lines of rivets, or nearly so, which makes it necessary to move the rails to obtain good holes and rivets. The second method (Fig. 2*b*) is to renew the top flange angles, cutting out and redriving the rivets connecting them to the web plates. This also requires the removal and replacement of angles connecting stringers to floor beams.

When there are cover plates, and only their connecting rivets are badly reduced, the rivets may be redriven, but when the plates also are badly reduced, they should be renewed with prepunched plates and reriveted. In order to provide room for this work, about half of the ties are temporarily removed. The remaining ties are shifted back and forth as necessary to expose all the

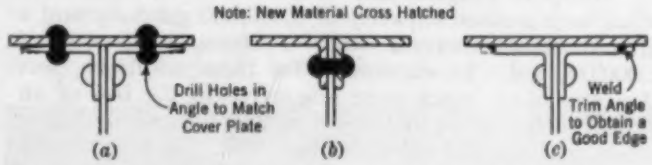


Fig. 2. Alternative Repairs to Corroded Flange Angle

(*a*) New Plate Riveted to Corroded Angles, (*b*) New Angles Riveted in Place, (*c*) New Plate Welded to Corroded Angles

rivets. This makes it necessary temporarily to reduce the speed of trains on the structure.

Much of the time and inconvenience of the methods described can be eliminated by the employment of welding. In the case of stringers without cover plates, the wedged and scalloped edges of flange angles may be cut back with a burning torch to where there is thickness enough to take a good edge weld. Plain plates can then be placed on the flanges and continuous fillet welds run along the cut edges of the angles, attaching the plates

and at the same time sealing any space between the angles and the plates (Fig. 2c).

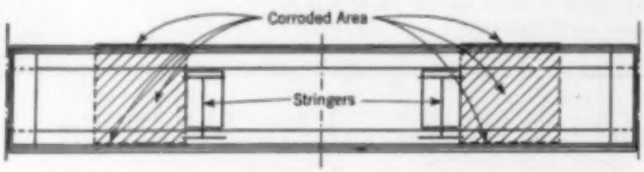


FIG. 3. CORRODED AREAS OF FLOOR BEAM TO BE REPAIRED WITH PATCH PLATES

In the case of stringers with cover plates, if the plates are suitable to be retained, the feather edges of the angles and plates may be trimmed back as necessary and continuous fillet welds run along the edges of the angles as described. If the plates require renewal, they should be removed, the flange angles cut back, and new plain plates applied and welded as previously described. This repair work leaves no rivets above the plates to corrode and require redriving later. To do this work, it is not necessary to remove any ties or shift them sideways. All that is required is to raise the whole track and deck intact, with track jacks, between trains, to insert cover plates on the stringers. Track and deck are then let down in normal position. The flame cutting and welding are done from below. In this way there is very little if any interruption to railroad traffic on account of the repair work. Similar treatment is applicable, if the stringers are I-beams.

Since girders and trusses have much greater sections than stringers, a loss of the same thickness of metal does not weaken them as much as the stringers. They therefore require much less repair as a result of corrosion, except the rivets. It is frequently necessary to cut out and redrive the rivets connecting cover plates to top flange angles of deck girders, and the upper angles in the top chords of deck trusses, on account of the loss of heads from corrosion. If, however, the rivet heads are not allowed to become reduced in size too much, or to become loose, they may be built up with weld metal at much less cost than for redriving. Heads built up with weld metal will outlast original or redriven rivets.

REPAIRS TO FLOOR BEAMS

Floor-beam sections are usually made up of a web plate, two flange angles, and one or more cover plates. The brine drip attacks the upper surfaces of the top flange, the web plates, and the bottom flanges (Fig. 3). Repair of corroded sections is simplified by welding new plates in place. The flange repair plate should be a little wider or narrower than the old plate to provide for fillet welds. The new plate should have holes to fit over the old rivet heads, and these holes are filled with weld metal to give a smooth surface. In some instances it is desirable to remove the corroded section of the old cover plate, insert a plain new plate, and butt weld its ends to the ends of the old plate. Fillet welds then attach the new plate to the old flange angles.

Webs may be repaired by cutting a patch plate with beveled edges to fit in between the top and bottom flange angles and the connection angles of the floor beams and stringers. All four sides are butt welded to the flange angles and the connection angles. This leaves a smooth surface and no additional rivet heads to become corroded.

This article is abstracted from a prize-winning paper in the recent competition of the James F. Lincoln Arc Welding Foundation of Cleveland, Ohio. The complete paper appeared in *Maintenance and Welding*, published by the Lincoln Foundation.

Soil-Cement Stabilization for Portsmouth, Va., Water Works Additions

By L. G. WILLIAMS, M. AM. SOC. C.E.

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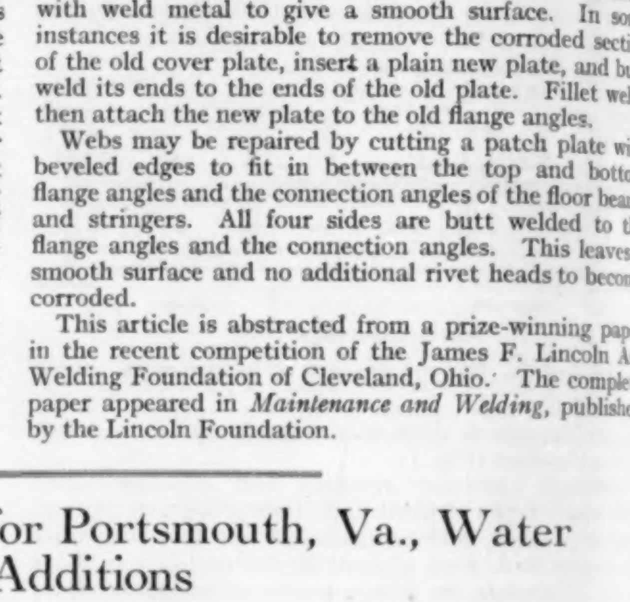
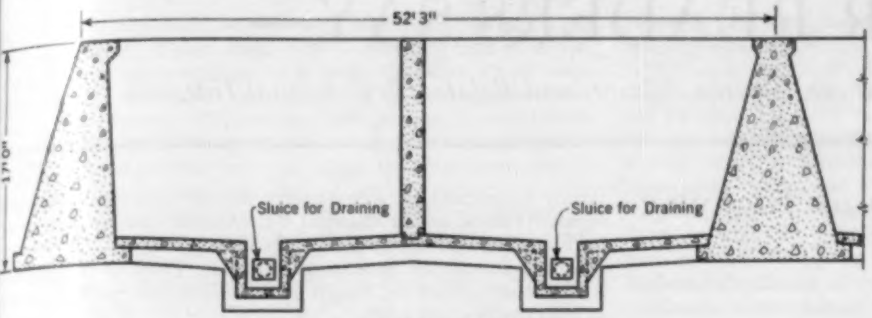
DURING 1943 additions were made to the water works of Portsmouth, Va., in the form of a filter plant with a rated capacity of 6,000,000 gal daily and a filtered-water reservoir with a storage capacity of 2,000,000 gal. In excavating for these additions, soft clay and black muck were uncovered in the bed of an old ravine below the footings of parts of the sedimentation basins and the filtered-water reservoir. In the interest of conserving reinforcing steel, at that time a critical material, the reaction and sedimentation basins were designed with gravity section walls of unreinforced concrete, plain concrete floors, and no roofs, Fig. 1 (*a*). The filtered-water reservoir was designed as a groined arch structure 190 ft long by 126 ft wide, inside measure, with a column spacing of 16 ft on centers, the entire structure being unreinforced throughout, Fig. 1 (*b*).

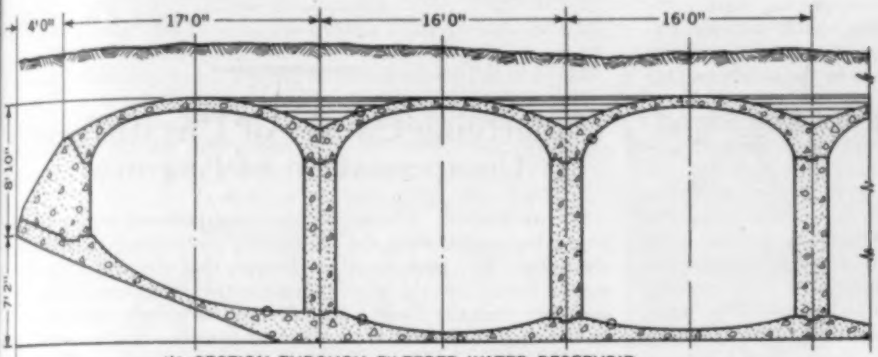
Had it been permissible to adopt the usual reinforced concrete design, the loads could have been distributed. The soft condition of the subsoil would then have been less important than with the gravity walls and arch design used. It was deemed essential to stabilize the subsoil at places where soft material occurred, by some method that would assure good results. Also, the



WHERE POSSIBLE SOIL CEMENT WAS MIXED IN PLACE BY HAND



(a) SECTION THROUGH SEDIMENTATION BASINS



(b) SECTION THROUGH FILTERED WATER RESERVOIR

FIG. 1. SECTIONS THROUGH ADDITIONS TO PORTSMOUTH WATER WORKS

method adopted must not require critical materials and should involve a minimum of delay to the work.

Several solutions to the problem were considered:

1. The first was removal of the soft material and backfilling with a selected material, such as sand and gravel, compacted in place. The difficulty of obtaining suitable selected fill and the uncertainty as to subsequent settlement of the compacted fill resulted in rejection of this method. The additional depth of excavation required for removal of the soft material would have been as much as 6 to 8 ft in places.

2. Another method considered was to remove the soft material and backfill with Class B concrete to support the walls, and with compacted selected fill under the floors. This method had the disadvantages of the selected-fill method, but to a less degree. An estimate of cost showed it to be more expensive than other acceptable methods.

3. The third method proposed was to replace the soft material with Class B concrete under the pipe gallery and with selected fill confined by concrete cells for the support of the walls. Estimates of cost for this method were less than for the second method, but it involved the use of considerable reinforcing steel.

4. The method adopted was to excavate the unsatisfactory subsoil below the structures and replace it with soil-cement. Estimates of cost showed this to be the most economical of the acceptable methods studied.

The material used consisted of sandy soil selected from the excavation containing 15%, or somewhat more, of clay. The specified mix was 1 part cement to 10 parts soil, measured loose by volume. As actually carried out, a sack of cement was taken as 1 cu ft, and the sand or soil was measured by wheelbarrows previously calibrated to $3^1/_3$ cu ft. Approximately 9 gal of water was used per sack, resulting in a mixture with a slump of about 6 in.

Some test cylinders were made as the work progressed. The 28-day compressive strength varied from 245 to 500 lb per sq in., and averaged 364. The minimum corresponds to some 35,000 lb per sq ft, which is about 10 times the design soil loading. The density varied from 112 to 127 lb per cu ft, and averaged 124.

Contract prices for the work, per cubic yard, were 87 cents for the additional excavation, and $7.30 for the soil-cement in place, or a total of $8.17 per cu yd. In all, 2,843 cu yd were required, bringing the cost for soil stabilization to $23,227.

The additions to the water works were built as a Federal Works Agency project under the regional office at Richmond, Va., headed by Kenneth Markwell, regional director. The work was supervised by the Norfolk office of the FWA, L. L. Pearsall, principal engineer, and Harry C. Cowl, construction engineer. Earl D. Covell was resident engineer on the project for Greeley and Hansen. The plant additions were built by the Ahlvin Construction Company with A. H. Regan, superintendent. The work was constructed for the City of Portsmouth, Arthur S. Owens, city manager; X. D. Murden, superintendent, Water Department; and O. F. Story, chief engineer, Suffolk pumping station.

SOIL TAKEN FROM THE BANK WAS MIXED WITH CEMENT IN TWO MIXERS, THEN WHEELED INTO PLACE

VIEW OF BASIN FLOOR AFTER EXCAVATION AND BEFORE PLACING OF SOIL-CEMENT

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Composite Construction on Highway Bridges

To the Editor: The article, "Welding to Ensure Composite Beam Action," by Glenn L. Enke, in the January issue, contains some interesting information regarding composite construction on highway bridges. Because of the ever-growing interest in this comparatively new type of construction—numerous state highway departments are using it extensively—such articles will probably be read with considerable interest by many civil engineers. However, we believe some statements in the article call for comment.

If unsymmetrical steel sections are used, there is not much difference in cost between a composite beam designed for both live and dead load and one designed for live load only. Such sections can easily be effected by welding cover plates to the bottom flange of rolled sections, or by using all-welded sections. The section in which composite action is assumed for live load only, requires very little more steel than the one in which composite action is assumed for dead and live load, and which therefore requires temporary intermediate supports. It requires considerable expense to make these temporary supports effective, as they have to support the concrete as well as the steel. One support in the center is sufficient, but even one will cost a great deal if the ground is not suitable for supporting a heavy load. A good example of an all-welded composite beam bridge of 120-ft span, designed to carry dead and live load, is the "Jordan Lane Bridge" erected in 1941 by the Connecticut State Highway Department (Civil Engineering for September 1943). The shoring height is about 16 ft, and only one temporary center support was used.

Mr. Enke's remarks regarding the plastic flow of concrete are interesting. It is about time for the designer of reinforced concrete T-beams to take plastic flow into consideration, especially in designing the section over the interior supports in continuous beams. However, if plastic flow affects a reinforced concrete structure, it also affects a composite beam that has temporary intermediate supports, because such a composite beam has a permanent compressive stress in the concrete due to the dead load. A composite beam that does not have temporary intermediate supports has only temporary concrete stresses due to the live load, and there should therefore be no plastic flow, as stated by Mr. Enke.

The important technical advantage of composite construction compared with plain steel beams and concrete deck is its much greater stiffness. However, in the computation of the dead-load deflection we are up against the same difficulty as with plain steel beams, unless very effective intermediate supports are used. For the computation of the live-load deflection almost the same uncertainty exists with respect to the correct n as in the case of reinforced concrete designs.

To judge from the illustrations, the bridges described by Mr. Enke seem to be of the continuous type. It would be of great interest to know how the problem of negative moments was solved with respect to composite action. Either the steel section alone sustains all stresses over the interior supports, or enough steel has to be placed in the top of the concrete slab to sustain the tensile stresses. If advantage of composite action was taken only for the positive moment, why then the heavy shear connectors over the interior supports?

The shear connectors used may well compare with angles, as mentioned by Mr. Enke, but compared with an inclined T-shaped or I-shaped connector, welded upright to the top flange, or with the well known spiral shear connectors, they are expensive. Connectors used in the two bridges, as well as angles, and channels, standing with the flange on the top of the beam, must be designed for bending. It does not seem permissible to assume that the shear connectors do not need an anchor to prevent uplift of the slab. Numerous tests on composite beams and the performance of many highway bridges have demonstrated that there is such an uplift. The shear connectors on the two bridges seem to be spaced uniformly throughout the whole length, and not adjusted to the actual shear. This is not economical. Composite beams, as described by Mr. Enke, do not require more than 1.5 to 2.0 lb of effective shear connectors per lineal foot of beam. From the photographs it would seem that the weight of the connectors used amounts to at least five times as much.

North Arlington, N.J.

C. P. Cueni
Vice-President, Porete Manufacturing Company

Underlying Causes of Unsatisfactory Compensation of Engineers

To the Editor: The present movement toward organization for improving conditions in the engineering profession is readily understandable. It is unfortunate, however, that the profession should now be forced to fight a self-defense action in an emergency. The very fact that the Society has reversed its former inflexible stand on the subject appears to be sufficient evidence that its goal is now to make the status of the engineering profession somewhat comparable to that of other professions. My purpose in the present comment is, therefore, mainly to determine whether the steps now being taken are likely to lead to the desired goal.

The "under-privileged" status of the engineering profession is a chronic condition, and no one realizes better than the average engineer-employee of forty and over the need for a drastic remedy. The unsatisfactory compensation of engineers is simply a surface symptom of underlying and deep-seated causes, two of which will be discussed here.

The first underlying cause may be designated "under-demand for services." Under normal conditions, there is a given average amount of engineering work needed every year. Competition among private concerns for the engineering work available is increasing steadily, too often resulting in inadequate bids and, at times, in poor and wasteful engineering. It is my belief also that too much of our engineering is still being done by rule-of-thumb methods that were suitable in the old days of plentiful materials and cheap labor supply. Conditions have changed, and engineering practice should change accordingly. The cost of engineering is only a small fraction of the total cost of a project and, as in other professions, the highest-priced talent is often the cheapest. On many projects engineering could be expanded very materially, without even approaching the point of diminishing returns on the total investment.

The second underlying cause may be designated "over-supply of men." Under normal conditions, there are too many men for the engineering work available. Many of these men are not professional engineers in any sense of the word, and often not even capable detailers. The oversupply of men too often puts a premium on quantity over quality, and the man with more experience, more initiative, and a greater sense of responsibility is at a distinct disadvantage in competition with the superficial worker.

Perhaps the profession is still somewhat under the influence of our pioneer period, when there was excuse for men outside the profession handling some of the engineering work then being done. But the involved and specialized type of work needed nowadays makes it difficult for even a graduate engineer to do a full day's work and keep abreast of developments.

The engineering profession should emulate the medical and legal professions, by gradually raising the standards of education and ultimately restricting practice to licensed professional men, properly protected by strong license laws. This would enable our profession to give the highest type of service, and would place it on a par with the other professions.

The steps now being taken by the Society appear to be simply an attempt to remedy the symptom of under-compensation with

easures akin to unionism, with little or no attempt to tackle the underlying causes. These steps will protect the rights of the engineers to self-representation, will probably bring about some improvement in the lower brackets, and may eliminate some "sweat-shop" practices. Yet these steps appear to be a palliative only. We must also realize that the war emergency has given us a large crop of non-professional and subprofessional men with a smattering of engineering who now consider themselves fully qualified professional engineers, and that in organizing local groups we must be on guard against the infiltration of such men, lest a bad situation be made still worse.

Properly enough the Society wants to keep the present movement on a dignified and strictly professional plane. However, in executing the details, some of the Local Sections may overlook the necessity of adhering to this requirement. Thus it would be well for the Society to insist that the Sections give some dignified and preferably standardized designation to their local groups, such as Associated Professional Engineers of (City or State)."

It seems to me that we are making a start on a road full of pitfalls and that we must supplement the present steps with a much broader and more drastic attack of the problem along the lines just described, if the desired improvement in the social and financial status of the engineering profession is ever to be attained.

Seattle, Wash. ADRIAN J. GILARDI, M. Am. Soc. C.E.

Backsight on Transport in Central America

DEAR SIR: Referring to Colonel Kelton's paper in the November issue—the writer saw the Pan-American Highway for the first time when he was in survey parties in Nicaragua and Costa Rica shortly after our war with Spain. The road from Managua north to the cattle and coffee country was used by riders in all seasons and by carts and wagons in dry weather. Over the Tipi-tapa River was an American iron Pratt-truss highway bridge of a type formerly familiar throughout the United States. It has been replaced by one of Uncle Sam's gift bridges.

Regarding railroads, there were two in Nicaragua, later one continuous line; several short lines in Guatemala and El Salvador; and one in Costa Rica (Puerto Limon to San Jose). Early in the century, a Mexican railroad was extended to the Guatemalan frontier and across the isthmus of Tehuantepec. In Guatemala, starting from the Mexican line, one ran parallel to the coast with branches to three ports, ascended to the capital, Guatemala City, thence to Puerto Barrios and, by an extension, eastward to the Gulf of Fonseca. An English company had a railway from San Salvador to Acajutla.

Another in Costa Rica and the Panama Railroad made in all four railroads from ocean to ocean, with a fifth route through Nicaragua by rail and steamboat. A railroad was built in western Panama, and there were logging and mining lines and banana railroads in eastern Nicaragua and northern Honduras. All these lines were in operation previous to 1920.

THE OLD TIPI-TAPA BRIDGE, NICARAGUA, JANUARY 1900
As Recently as 1932 It Carried 3-Ton Truck Loads

Motor vehicles appeared in Central America almost as early as in the States. Of course, there were a number of motor highways in Panama. At the start of construction of the Panama Canal, a highway was built from the port of Balboa through Panama City, and for some ten miles eastward. The first automobile, imported into the country from France, was run over the highway in 1906. Before 1925, the Republic of Panama had constructed a motor highway to David, and a motor truck service moved coffee from the plantations of El Salvador to the port of La Libertad over an improved highway. In 1928, or shortly after, two Germans, who were making what they called an exploratory motor trip from Buenos Aires to the United States, passed through Managua and continued on their way northward.

At about the same period, the writer operated trucks through the central part of Nicaragua, and frequently traveled by motor

INTER-AMERICAN HIGHWAY IN GUATEMALA
View West of Guatemala City near Chimaltenango

over the old dirt roads. Military forces (and U.S. Marines) used motor transport to outlying posts. In 1930 a private truck line carried freight between Matagalpa and the capital, and there were many passenger cars and crudely built motor-buses in operation.

In 1932 the writer traveled by automobile from near the Mexican border over the entire extent of the Inter-American route in Guatemala and also from the capital to Pacific ports, as well as interior points. No fogs, continuous or otherwise, were observed, except once at night in a short period of rain. In 1935, private automobiles, motor-buses, and trucks operated from Guatemala City to San Salvador at speeds equal to that noted for Colonel Kelton's pioneer trip. Motor vehicles used various roads radiating from San Miguel to the vicinity of the border of Honduras.

Thus it would seem that Colonel Kelton's statement as to the non-existence of any highway and rail transport between the periods of the ox-cart and airplane was something of a figure of speech, not needed to indicate the value of his construction accomplishments.

Practically the only portion of the 1,500-mile Inter-American route, which runs through hitherto non-traversed territory, is the section in the Costa Rican forests. The difficulties of transportation, referred to in the editor's introduction, were caused by war conditions. There are no "remote regions" in the area under consideration that were not accessible in pre-airplane days for personnel and supplies by rail, cart, or pack-animal from various ports.

New York, N.Y. HENRY WELLES DURHAM, M. Am. Soc. C.E.

Montecassino and the Early Water Supply of Rome

TO THE EDITOR: With the whole world interested in the Allied invasion south of Rome and the destruction of the Monastery of Montecassino, it occurs to me that a few comments based on Frontinus' description of the water supply of the city of Rome might be of interest to the readers of CIVIL ENGINEERING.

As is well known, on February 15 the Allies, moved by military necessity, destroyed by air and land bombardment the Monastery of Montecassino, one of the great monuments of early Christian history. The monastery—at the very apex of Mount Cassino—was founded and established by St. Benedict in 529, but the main buildings date from the sixteenth and seventeenth centuries. Its site was originally that of a pagan temple. The old sixth century Benedictine Abbey was a veritable city, with power plants, church, monastic dormitories, mosaic factory, and art galleries, while its collection of old, rare, and priceless manuscripts was one of the finest in the world.

In past centuries Montecassino was destroyed successively by the Lombards, the Saracens, and the Normans, and in 1349 by an earthquake. It is unthinkable, of course, that the Catholic Church will not again, in time, restore this ancient edifice, which for so many centuries has stood for its ideals and civilizing influence.

About the twelfth century—the exact date is unknown—there came into the possession of the Chief Abbot of the Monastery the valuable codex on the Water Supply of Rome, written by Sextus Julius Frontinus, water commissioner of the City of Rome, 97 A.D. This treatise by Frontinus gives a description of the location, maintenance, and construction of the aqueducts coming into Rome from the mountains surrounding the city, the method of distribution, and the taxation system necessary to administer such a system. It is sincerely to be hoped that this old manuscript was not destroyed, but that it will be found intact when the process of restoration takes place. Fortunately, a photographic copy of this sole original manuscript has been preserved in Clemens Herschel's book, entitled *Frontinus and the Water Supply of the City of Rome*, published in 1899. A second edition, with revisions, was published in 1913. Mr. Herschel, President of the Society in 1916 and 1917, visited the monastery in November 1897 and was allowed to examine the manuscript by the Benedictine Brethren, who also permitted him to procure a photographic copy of it.

In 1899 his book appeared, with a photographic reproduction of the original Latin manuscript with its reprint in Latin as well as a translation into English of this valuable document. I have a copy of the 1913 edition of this volume in my library, which I prize very highly. I know of no treatise on early water systems of the world that interests me more deeply than this highly entertaining and instructive volume on the early water system of Rome.

On two different visits to Italy I spent considerable time in looking over the water system of Rome, which was built during the time of the Caesar's. In fundamentals—in the method of transporting the water, its distribution and taxation—it differed little materially from present methods used throughout the world. It is true, of course, that our methods of construction differ greatly from the old Roman methods, but the underlying and fundamental principles of the systems are largely the same.

The engineering profession owes a great debt to Mr. Herschel for his remarkable treatise on the water supply of Rome, and for making available the photographic copy of the Frontinus manuscript.

Buffalo, N.Y. EDWARD P. LUPFER, M. Am. Soc. C.E.

Can Bridges and Other Structures Be Too Durable?

DEAR SIR: A letter from one of my associates on a committee lists the expected life of a bridge as seventy years in computing the number of heavy loads that may be expected to pass over it.

This question of expected life of a structure has always been a puzzle to me. The recent report of the National Inter-Regional Highway Committee states that the roadway and structures are to provide for traffic expected twenty years after construction. I interpret this to mean that a bridge will carry the traffic satisfactorily twenty years after it is constructed. Of course, it will serve longer than that, but it is not guaranteed to serve satisfactorily or economically beyond that time. The statement is one of the first I have seen from highway engineers, which really meets the needs of the American way of living. We point with pride to old structures for their historic value, but deep in our hearts we know how much better off the community would be if they were replaced with modern structures adequate to take care of the requirements.

How much alinement in the location of modern highways has been ruined in order to use an old structure that is still good but hardly adequate. And what wouldn't we give, if the buildings in some of our large cities had not been constructed so substantially, so we could widen our thoroughfares through them without paying such an enormous price for rights of way? Rockefeller Center was constructed on the basis of a useful commercial life of forty or fifty years. The buildings at the World's Fair in New York were constructed for a two-year period.

To plan the construction of American highways and bridges beyond one generation seems out of line with our mode of life, which is ever changing. Why "kid" ourselves into thinking we are building a bridge that will be adequate for the next seventy years, when we know our guess comes in the class of weather predictions?

My thought on this is to build for the next twenty-five or thirty years and then let the next generation of engineers be free to choose a structure better suited to their needs rather than to tie them down to some obsolete structure which has been constructed to "live" a hundred years but to serve only twenty-five years.

This should not be interpreted as meaning that we are not to build beautiful and substantial structures. Our roadway structures must be built to withstand the ravages of man and the elements, and should be worthy of "our hire"—but not for the next hundred years when trucks with folded wings may be using them to go to an airport to take off. It would be interesting to receive other viewpoints on this subject.

Edmonton, Alberta RAYMOND ARCHIBALD, M. Am. Soc. C.E.

Forum on Professional Relations

CONDUCTED COLUMN OF HYPOTHETICAL QUESTIONS WITH ANSWERS BY DR. MEAD

In the current issue Dr. Mead gives his answer to Problem No. 19, which was announced in the February issue of "Civil Engineering." The problem states: "A consulting engineer is employed by a municipality to examine the safety of the design of a muncipal structure which is to be built from plans from another consulting engineering firm. During his examination it becomes quite clear that the construction cost will be high, that the annual operating expense, including maintenance and depreciation, will be exorbitant, and that there will be a large waste of public funds. What obligation, if any, does the consulting engineer have in the matter of reporting this to the municipal authorities?"

If the writer were asked to examine plans prepared by another engineer for a municipality, which he believed to be an honest attempt to solve the problem at hand, he would refuse the work unless he could do it with the knowledge and consent of the designer and could reserve the right to discuss his own findings with the designer if he found the two ideas about the plans differed materially. If he could not convince the original designer to modify the plans so as to make them satisfactory (if that were possible), he would report in detail to the municipality his reasons for finding the cost too high, the expenses exorbitant, and the waste involved. He would also advise the abandonment of the venture. However, if the municipality decided to proceed with the plans in spite of his adverse report, he might—to protect the public interests—apprise the public of his reasons for thinking that carrying out the plans would be a waste of public funds.

Questionable plans should be discussed until a plan results that will be of advantage to the public.

Madison, Wis. DANIEL W. MEAD, Past-President and Hon. M. Am. Soc. C.E.

Replies for the following question may be received until May 5, with answers in the June issue.

QUESTION No. 21: *An engineer is making plans and specifications for a sewer system. Is it ethical for him to be financially interested in a concern manufacturing an article that may be used under the specifications, such as sewer pipe?*

SOCIETY AFFAIRS

Official and Semi-Official

St. Louis Section to Entertain

Board of Direction Sessions and Regional Meeting to Be Combined at Coronado Hotel the Week of April 23

ROM Sunday through Thursday, April 23–27, a series of meet- s will be held in St. Louis, primarily designed for regional at- dance but of interest to all members. These sessions take the e of the usual official Spring Meeting of the Society. That is, Board of Direction and such other members as can conven- tly attend, will join with the Local Section in a special arrange- nt of technical and social events. The Board meetings will ur from Sunday through Tuesday, the Local Section Conference t for all day Tuesday, and the Section's meetings are scheduled Wednesday and Thursday.

t. Louis was chosen for these events in part because of its tral geographic location, but also on account of its scenic and ineering interest, and capable planning by an active Local tion. Transportation being a problem, the fine facilities for ching St. Louis are a favorable factor. Local accommodations l be furnished by the Coronado Hotel, where all the meetings scheduled.

A Full Schedule

n order, these begin with the meetings of the committees of the ard, planned for Sunday, April 23. The following two days reserved for the regular meetings of the Board, which will sider the many Society activities requiring decision as to policy administration, with sessions both morning and afternoon— ning, too, if required.

Coincident with the Tuesday Board meeting, there will be a full y of Local Section activities. These comprise a regional con- ence attended by representatives from a wide area. Dele- tes from as far away as Florida in one direction and Minnesota another, and from the entire Gulf region to the Great Lakes have n invited to be present. Problems of peculiar importance and erest to officers and local members will be presented and dis- sed. Aside from the pleasure of social intercourse, these con- ences always encourage dis- sion of alternative methods d points of view, and gener- ideas of practical value in conduct of Local Section airs.

Technical meetings arranged a regional gathering such this have the advantage that re is a single program with overlapping of sessions. ch of the three technical sions in St. Louis will have own theme. On Wednes- y morning it will be the local blems of the city and vicin- y of St. Louis; in the after- on, the several viewpoints flood control, both general d local; and on Thursday rning, war and postwar gineering. In addition, a neral lunch has been arranged Wednesday and a dinner nce for that evening. In cordance with regular war- ne procedure, at Society arterly meetings the dress the dinner will be informal.

As now set up under the local committee on arrangements, H. F. Thomson, general chairman, the program of these St. Louis Section meetings appears as follows:

Wednesday, April 26

Morning Session, R. W. Hodson, *President St. Louis Section, Presiding*

9:00 a.m. **Registration** (no fee)
Lounge Room

10:00 a.m. **Opening session** called to order in the Crystal Room by
R. W. Hodson, *M. Am. Soc. C.E., President, St. Louis Section*
Invocation
Address of welcome
Aloys Kaufman, *Mayor of St. Louis*
Response by W. W. Horner, *M. Am. Soc. C.E.*

10:30 a.m. "The Needs, Physical and Economic, of the City of St. Louis in the Postwar Era"
George C. Smith, *President, St. Louis Chamber of Commerce*
Open discussion

12:30 p.m. **Luncheon in the Club Caprice,** price $1.50
Address by President Malcolm Pirnie, "The Society and Its Work"

Afternoon Session, H. E. Frech, *Assoc. M. Am. Soc. C.E. Presiding*

2:00 p.m. "Fundamentals of Flood Control"
Col. Malcolm Elliott, *M. Am. Soc. C.E.*,

Memorial Plaza and St. Louis Terminal

THE EADS BRIDGE OVER THE MISSISSIPPI AT ST. LOUIS

Division Engineer, Upper Mississippi Valley Division, St. Louis, Mo.

3:00 p.m. "Flood Control Plans for the Missouri River"
BRIG. GEN. ROSCOE C. CRAWFORD, *Division Engineer, Missouri River Division*

4:00 p.m. "Flood Abatement by Headwater Measures"
HOWARD L. COOK, *M. Am. Soc. C.E., Technical Adviser on Hydrology, Office of Land Use Coordination, U.S. Dept. Agriculture*, Washington, D.C.

4:45 p.m. "Economic and Political Considerations Underlying Flood Control"
THE HON. BENNETT CHAMP CLARK, *U.S. Senator from Missouri.*

5:15 p.m. Adjournment

6:00 p.m. Social hour—El Cortez Cocktail Lounge

7:00 p.m. Dinner in Club Caprice, price $3.00. Speaker, PROF. GUS DYER of Nashville, Tenn.
Following the dinner there will be dancing until midnight.

THURSDAY, APRIL 27

Morning Session, ROBERT B. BROOKS, *M. Am. Soc. C.E., Presiding*

Technical Sessions in Crystal Room

9:30 a.m. "Postwar Inter-Regional Highways"
CARL W. BROWN, *Chief Engineer, Missouri State Highway Department, and President, American Road Builders' Association*

10:00 a.m. "The Postwar Federal Aid Highway Program"
SAMUEL C. HADDEN, *Chairman, State Highway Commission of Indiana, and President, American Association of State Highway Officials*

10:40 a.m. Discussion

10:50 a.m. "War Jobs and Then What?"
COL. WILLIAM N. CAREY, *M. Am. Soc. C.E., Chief Engineer, Federal Works Agency*, Washington, D.C.

12:00 m. Adjournment

The appearance of President Pirnie on the program will mark his first attendance at a quarterly regional meeting. Another well-known figure is Dr. Dyer, whose brilliant analyses of economic and historic matters are known widely. Those who heard his fascinating and witty address at a similar meeting at Birmingham, Ala., in the fall of 1935, will need no further recommendation.

As always, ladies are more than welcome at these meetings. They are expected to attend the Wednesday morning session. In the afternoon they will assemble at the Missouri Athletic Club for luncheon at 12 o'clock. Immediately afterward they will take a short walk to the old St. Louis Court House, where John Bryan, curator, will conduct the group through the building and give a brief talk on "Historical St. Louis—Gateway to the West." Following this, another short walk will bring the group to the old St. Louis Cathedral, one of the historic points of interest.

All of Thursday afternoon has been reserved for a joint inspection trip to the Granite City Engineer Depot, Granite City, Ill. Special cars will be provided at the Illinois Terminal Station to make the trip to Granite City, where the Engineer Depot will take charge and furnish transportation. Following luncheon, to be served at the depot, an inspection tour and demonstration of the widespread activities of the depot will be given. This combined trip for both men and ladies will conclude the meeting, which will stand adjourned as of the return to St. Louis—in time to catch early evening trains, if necessary.

It is just 180 years since St. Louis, or what is now St. Louis, was first visited by the white man. In the intervening years, the city has remained a center of transportation, art, education, and national affairs. Reminders of a great and colorful past are still the objectives of all visitors. Echoes of the Dred Scott case may be heard, and of the footsteps of Webster, Lincoln, and Grant. The memory of Jefferson is being especially perpetuated in St. Louis. Also of great historic value is an engineering structure that marks a great epoch and a great engineer—the Eads Bridge across the Mississippi.

Of more recent note, the visitor will be interested in the great Forest Park, in the art museum, and the site of the St. Louis International Exposition, in the noted zoological gardens, and in countless other items of modern interest.

With these attractions as a background, and with a splendid technical program for engineering and professional diet, the St. Louis Section offers many inducements to Society visitors. It extends a sincere invitation to all those who may find it possible to join in its meetings, April 26 and 27, 1944.

Sizes of Professional Cards Standardized by Committee on Fees

THE COMMITTEE on Fees has recommended that the size of professional cards published in engineering magazines be standardized. The intent of this action is to draw a sharp line between the cards of professional engineers and advertising. Each publication will of course establish its own size of card, but will be encouraged to use that one size only. An extract of the report of the Committee follows:

"1. The committee is of the opinion that uniformity of size of professional cards is highly desirable. The problem is not related to fees but is rather one on the fringe of ethical procedure. The demarcation between a professional card and advertising would be much sharper if all professional cards of consulting engineers in a given magazine were of uniform size.

"2. Like other considerations involving even to a small extent the question of ethics, the solution should be within our own membership. The committee recommends that CIVIL ENGINEERING give publicity to the fact that the question has been raised and that the Committee on Fees has made a recommendation that all professional cards of consulting engineers in a given magazine be of a uniform size.

"3. If after this publicity in CIVIL ENGINEERING the practice persists, the committee suggests that copies of the resolution be sent to magazines in which consulting engineer members of the American Society of Civil Engineers carry other than the standard size professional card."

Advancement of Sanitary Engineering

Digest of Three Reports Presented to Annual Meeting of Sanitary Engineering Division, January 20, 1944

Committee Chairman's Report

By GORDON M. FAIR, M. AM. SOC. C.E.

PROFESSOR, SANITARY ENGINEERING, HARVARD GRADUATE SCHOOL OF ENGINEERING, CAMBRIDGE, MASS.

his is an informal progress report by the chairman of your Com-tee on the Advancement of Sanitary Engineering—a token re-t, as it were. Two years have elapsed since Prof. Charles Gilman e presented a "completion" report of this committee before quishing its chairmanship. In the intervening biennium, san-y engineering has marched on. Certain developments of broad rest to the profession are treated in the following reports. About r developments a word may not be out of place.

WARTIME EDUCATION OF SANITARY ENGINEERS

he academic flame of sanitary engineering, which was about to with the closing of the last more-or-less normal academic year 942-1943, has flickered back to life within the last few months, sed by the Training Division of the U.S. Army through the y Specialized Training Program. The program of engineering ning is established in three phases: a basic phase of three 12-k terms (terms 1 to 3) in engineering; an advanced phase of e 12-week terms (terms 4 to 6) in civil, mechanical, electrical, or mical engineering; and a specialists' phase of varying duration uding two 12-week terms in sanitary engineering (terms 7 and

o man is admitted to the program until he has completed his c military training. Depending upon his educational qualifi-ons, he may, upon examination, then enter any one of the eight ns. The specifications for the seventh and eighth terms of in-ction in sanitary engineering call for graduate civil or chemical neers or for men who have completed the sixth term of training ivil or chemical engineering.

ither the seventh or eighth terms, or both, have been in opera-n in five universities—Harvard, Illinois, Michigan, New York, Rutgers. The eighth term, owing to lack of candidates, is n in but one—Michigan.

ome students, upon completion of the seventh term, are called the Service of the Corps of Engineers; others will be permitted omplete the eighth term before being sent to Officers' Candidate ool to be trained for eventual commissions in the Sanitary Corps he Army. By these means, a continuing supply of young sani-y engineers is being developed, at least in a rudimentary fashion, h for the Army and for later civilian activities. The reorgani-ion of the U.S. Public Health Service has but recently been com-ted. It consists of the Office of the Surgeon General, the Na-al Institute of Health, and two bureaus—the Bureau of Medical vices and the Bureau of State Services. Within the Office of the rgeon General is established the Division of Sanitary Engineer-, the chief of which, John K. Hoskins, holds the title and grade an Assistant Surgeon General. The law authorizing this reor-nization was supported by the Society. Of interest in connec-n with this law is the protection comparable to that for officers the armed forces, which has been extended also to officers of the blic Health Service. It should be noted that the choice of this well as other federal services has remained not for the title ublic health engineer" but for the title "sanitary engineer."

Public Health Service Reorganization Order No. 1, dated De-mber 30, 1943, provides:

"*Sanitary Engineering Division.* This Division will have general pervision over all sanitary engineering and sanitation operations rried on by the Public Health Service, and professional super-ion over all sanitary engineering personnel of the Public Health rvice including personnel assigned for duty with other govern-ntal agencies. The Chief of the Sanitary Engineering Division ll advise the Surgeon General regarding plans, programs, and licies for the Public Health Service in relation to sanitary engi-ering and sanitation activities, including standards for sanitary gineering and sanitation personnel, and projects for sanitary gineering and sanitation research. The functions of the Sanitation Section in the Division of Domestic Quarantine (States Relations) and of the Stream Pollution Laboratory at Cincinnati, Ohio, in the National Institute of Health, are transferred to this Division."

DEFINITION OF THE TERM "SANITARY ENGINEER"

By agreement with the U.S. Civil Service Commission, the Procurement and Assignment Service of the War Manpower Commission has adopted the following definition of the term "Sanitary Engineer":

"For the purposes of clearance with the Procurement and Assignment Service of the War Manpower Commission, the professional occupational title 'sanitary engineer' shall apply to a graduate of a full 4-year, or longer, course leading to a bachelor's, or higher, degree at a college or university of recognized standing with major study in engineering, who has fitted himself by suitable specialized training, study, and experience (*a*) to conceive, design, direct, and manage engineering works and projects developed, as a whole, or in part, for the protection and promotion of the public health, and (*b*) to investigate and correct engineering works and projects that are capable of injury to the public health by being or becoming faulty in conception, design, direction, or management.

"Successful performance in the field of sanitary engineering requires an intimate and working knowledge of the basic physical, chemical, biological, and engineering sciences upon which the profession is based, and the ability to identify, evaluate, and explain in terms of their sanitary and public health implications those environmental factors that will promote and protect health, as well as those environmental factors that are capable of injuring health.

"The practice of sanitary engineering includes the following activities:

"(*a*) Surveys, reports, designs, direction, management, and investigation of:
  "(1) Water works or sewerage systems, and closely related engineering structures.
  "(2) Projects relating to stream pollution, waste disposal, insect and vermin control or eradication, rural and camp sanitation, housing sanitation, and milk and food sanitation.
  "(3) Systems for the prevention of atmospheric pollution or the control of indoor air, especially the air of working spaces in industrial establishments (industrial hygiene engineering).

"(*b*) Professional research and laboratory work supporting the activities listed in (*a*).

"(*c*) Responsible teaching of sanitary engineering and closely related subjects in colleges or universities of recognized standing."

Some Activities During the War

By ABEL WOLMAN, M. AM. SOC. C.E.

CHAIRMAN, COMMITTEE ON SANITARY ENGINEERING, NATIONAL RESEARCH COUNCIL, WASHINGTON, D.C.

FOR CENTURIES war has intensified both the sanitary hazards threatening, and the sanitary precautions for safeguarding, military populations. Battles and wars have been won or lost more often because of water supply or disease than because of the force of weapons. This war is no exception, aside from the fact that its tempo is more rapid, its geography more widespread, and its exposures to environmental and other diseases more frequent and unusual. It is not surprising, therefore, that the sanitary engineer has found once more an important key role to play in the complex logistics of modern warfare.

Perhaps the first organized official effort to implement sanitary engineering activity on a national and global basis was taken by the National Research Council when it created, through its Com-

mittee on Medical Research, a Committee on Sanitary Engineering. This committee held its organization meeting in Washington, D.C., on August 11, 1942. It was established at the request of the Surgeons General of the Army, the Navy, and the U.S. Public Health Service, (1) to review the functions of the particular divisions of these agencies which are concerned with sanitary engineering, (2) to consider and advise upon special problems assigned to it by these agencies, (3) to formulate general policies in regard to sanitary engineering practices, and (4) to develop plans for providing and training sanitary engineering personnel.

Early in its deliberations the Committee organized upon the basis of three permanent subcommittees—on Policies and Standards Practice, on Training, and on Personnel.

Its meetings, usually in Washington, are always attended by the liaison officers of the Army, the Navy, and the U.S. Public Health Service, and more recently by liaison representatives of the Office of Civilian Defense, the Coordinator's office, the War Manpower Commission, the Board of Economic Warfare, and such other federal agencies as subject matter and problems may require. On occasion, representatives of foreign governments attend, who may be interested in procedures or in technical questions before the Committee. Representatives of the National Research Council, Division of Medical Sciences, always attend.

Issues before the Committee are freely discussed by members and by liaison officers, but voting on any question before the Committee is restricted to the civilian members of the Committee, in order to preserve the objective point of view of the Committee with reference to debatable military or semi-military policies or practices. Doctors, entomologists, biologists, physiologists, as well as engineers, participate in the discussions.

In addition, the Committee has created from time to time special or temporary subcommittees to concern themselves with special assignments of an immediate or temporary character, upon which prompt study and decision may be made. Practical problems or questions raised either by one of the military or semi-military agencies or by the Committee itself are treated under the following headings: on Specialized Engineering Curriculum, on Standards, on Amebiasis, on Control of Air in Barracks, on Feeding Garbage to Hogs, on Rodenticides, on Cross Connections, and on Standardization of Manuals of Practice. One of the Central Committee's early accomplishments was the inclusion of sanitary engineers in the specialized group to be cleared by the Board of Procurement and Assignment of the War Manpower Commission for military and civilian uses, as had already been the practice of the Board with respect to the procurement and assignment of doctors, dentists, veterinarians, and nurses. The Central Committee acts as an Advisory Commission to the War Manpower Commission, while the chairman of the Sanitary Engineering Committee serves as a member of the Board of Procurement and Assignment. In each state, a State Chairman has been appointed to act as the local clearing house for personnel. He is the official agent of the Manpower Commission. In most instances this individual is the State Sanitary Engineer or a person thoroughly familiar with the sanitary engineering personnel in the state.

Another important by-product has been to secure wider recognition of the importance of sanitary engineering specialized services in war. Expansion in this field has paralleled the discussions within the Committee, notably in the Office of the Provost Marshal General of the Army, in the Bureaus of Yards and Docks, Medicine and Surgery, and War Plans, all of the Navy; in the Office of Foreign Relief and Rehabilitation; and it is hoped, before long, in the Maritime Commission and in the Coast Guard.

Active work in this field, of course, had been already under way in the Office of the Coordinator of Inter-American Affairs and in the War Production Board. The creation, by the Pan American Sanitary Bureau, of a Committee on Sanitary Engineering for the countries south of us, under the chairmanship of the writer and composed of key officials in Central and South America, marks a recognition for the first time of the continuing major importance of the control of the environment in these areas, and provides the machinery for continuing study and influence.

The impetus given by the war to sanitary engineering operations, research, and organization has already produced significant technological progress in the science and art and important extensions in official policy and machinery. Many of these advances have taken place for the first time since the creation of some of the important military and semi-military agencies, and will of course survive the changes necessarily occasioned by the peace.

Since Pearl Harbor, important progress of lasting value has been made in every phase of sanitary engineering organizational machinery and practice. War has telescoped and sped up these changes, and with peace will come the problems, equally difficult, of adjustment and of application of ideas, policies, and machinery to the more orderly pursuits of civilian life. Already these aspects of transition are being given serious consideration by similar groups.

Procurement and Assignment Service for Sanitary Engineers, WMC

By DAVID F. SMALLHORST
CAPTAIN, SANITARY CORPS, A.U.S.

THE PROCUREMENT and Assignment Service for Sanitary Engineers of the War Manpower Commission was organized early in 1943 to provide for an orderly withdrawal of sanitary engineers from civilian life to meet the military needs and to best utilize the services of the limited number of sanitary engineers in this country. The necessity for such a service became obvious in 1942 during the rapid expansion program of the armed forces. Since the supply of trained sanitary engineers in this country has always been limited, concern was expressed by both governmental and private agencies about the apparent large demands of the armed forces, which, if met, might prove detrimental to the health of the civilian population, unless supervised by some agency having in mind the needs of the armed forces as well as the value of sanitary engineers in civilian life.

Under the Service a Sanitary Engineering Advisory Committee was appointed, as already described by Dr. Wolman, its chairman, to ensure adequate utilization of sanitary engineers in both the armed forces and civilian life.

At the first meeting of the Advisory Committee in January 1943 the objectives of the organization were outlined and decided upon. The functions, or methods of attaining these objectives, were formulated as:

1. To determine the military and civilian needs for Sanitary Engineering personnel for this country and abroad.
2. To estimate the availability of Sanitary Engineering personnel of various ages and grades of experience.
3. To establish a plan for a well-balanced allocation, in so far as practicable to meet the civilian and military needs.

In order to insure attainment of the functions outlined, additional policies had to be formulated, namely:

1. To define the term "sanitary engineer."
2. To derive a criterion which would establish the essentiality of sanitary engineers in other than military activities.
3. To outline the procedures to be followed in determining the essentiality of an engineer or his availability to the armed forces.

After considerable deliberation, the Advisory Committee accepted the definition of a sanitary engineer, as already given by Professor Fair.

The Advisory Committee then adopted a criterion for the determination of essential sanitary engineers in public health service. These criteria include positions considered essential to the safeguarding of civilian health, using the population served as a basis for the number of sanitary engineering positions necessary. In this way, certain positions are declared essential: therefore, the engineer filling that position is considered essential, provided he meets the War Manpower Commission's definition of a sanitary engineer and has occupied that position for at least 2 years. If the engineer declared essential, in accordance with this criterion, is under 3[illegible] years of age, the committee reserves the privilege of reviewing the ruling after a sufficient period has elapsed to obtain and train a replacement. The activity report of this service is as follows:

1. Names of sanitary engineers were obtained from the National Roster, engineering societies and organizations, mailing lists of technical engineering magazines, public health associations, state rosters of registered professional engineers, and other similar sources. Questionnaires were sent to these individuals. The returns were surprisingly successful, since of the 6,515 forms sent out we now have 5,572 names in our master file.

. As the questionnaires were being received, classified, and d, the State Advisers were submitting their lists of essential pons in public health services in their respective states, and rmation about the men filling these positions. As these lists e received, the committee reviewed the cases and ruled on their ntiality or non-essentiality.

. The needs of the Army, Navy, and U.S. Public Health Ser- e were obtained early in the program. To fill these needs:

a) One of the questions on the questionnaire requests the engineer's preference as to branch of the armed forces. According to the preference indicated, this engineer's name is referred to that agency. If it does not utilize his services, his name is referred to the agency indicated as second choice, etc.

b) Information not listed in our files is obtained through the State Adviser and forwarded to the requesting agency through the Procurement and Assignment Service for Sanitary Engineers.

c) The Officer Procurement Services were directed not to solicit sanitary engineers declared essential by the Procurement and Assignment Service for Sanitary Engineers; consequently, the procurement services are kept informed of all engineers ruled essential.

d) As the program progressed, it was decided that the Service could function more efficiently by decentralizing the functions of the Washington, D.C., office to the State Advisers. Consequently, on or about June 1, 1943, the State Advisers were delegated the authority to declare sanitary engineers essential or available.

The relationship between the Procurement and Assignment Serv- e for Sanitary Engineers and the Selective Service System has en a source of concern until recently. Arrangements were made rly in the program to place the sanitary engineers ruled essential y our Service in the same category as physicians, dentists, and terinarians. Occasionally an engineer previously ruled essential uld be reclassified and subjected to draft. When this occurred, e State Adviser was instructed to notify the Procurement and signment Service for Sanitary Engineers in Washington, D.C., ho in turn would notify Headquarters, Selective Service System, r appropriate action. This arrangement has produced very favor- le results.

A few statistics obtained from our roster of sanitary engineers clude:

Total questionnaires sent out	6,515
Total names in file, classified	5,752
Total in armed forces (Army, Navy, U.S.P.H.S. and unknown of the 5,752)	1,223
Total declared essential	515
Total declared available	288

The objectives of the Procurement and Assignment Service for nitary Engineers of the War Manpower Commission are being alized. A roster of sanitary engineers is being formulated; the ithdrawal of sanitary engineers into the armed forces is about mplete since the Army (the largest user of sanitary engineers) ased commissioning from civilian life, effective January 1, 1944; d the allocation of sanitary engineers to meet civilian needs is w in progress.

Constitutionality of Illinois Registration

QUESTION has been raised regarding the validity of the Illinois rofessional Engineering Act by a decision recently handed down y Circuit Court Judge Victor Hemphill, at Carlinville, Ill. The linois Act, which became effective on August 1, 1943, provides for gistration of various branches of engineering. Like most of the ther state laws, it was based largely on the so-called "Model aw," sponsored by the Society in progressively revised forms since 911 and finally adopted in 1932.

In the opinion of Judge Hemphill, the Illinois Act is unconstitu- ional. He criticizes the Act "as delegating legislative power to the registration) department and because it is indefinite and incom- lete."

If this decision that the Act is unconstitutional is maintained in higher courts, it will tend to cast discredit on other state acts, even though they may not be identical with the Illinois law. A more immediate concern as regards Illinois engineers is that they are deprived of the benefits of their own law.

For these reasons all engineers have an interest in supporting registration legislation. It is understood that an effort will be made to appeal the current decision. The Society's Committee on Registration of Engineers will be called upon to follow the developments and render all aid within its power.

Yearbook for 1944

FOR MONTHS an entire department of the Headquarters staff has been whipping into shape the 1944 Yearbook of the Society. The results are about ready for submission to all members. Indicative of the consistent growth of the Society is the total number of alphabetical entries for 1944, which is 19,600, as compared with 18,539 in 1943.

The paper shortage continues to have an effect on the amount of material that can be included. The major loss for the 1944 issue will be the geographic list. However, in wartime, when so many members make frequent changes of location, this list has less importance. The addresses of members serving in the armed forces have been revised in certain cases to omit regiment or battery numbers, and the same is true of naval ships and stations. Such deletions are in accordance with instructions from the Office of Censorship.

Other sections of the regular Yearbook which were omitted from the 1943 edition will also be absent from the current number. Such omissions are the full list of prize winners, life members, and past and present officers; also parts of the General Information section and of the Annual Report. As for the latter, it can be obtained in full on request to Headquarters. Because of these omissions, members will wish to consult the 1942 Yearbook for complete information on Society organizations and functions; and the 1943 Yearbook for the latest available geographical distribution.

The paper situation has also made it difficult to maintain the proper publication schedule. This is a case not so much of lack of paper as of difficulty in obtaining it on schedule. With the cooperation of the manufacturers and the printers, we have fortunately been successful in securing the necessary supply. Where deadlines could not quite be met, our printers have responded by accelerating their work schedule. It is believed, therefore, that the Yearbook will appear on time—a most creditable accomplishment. As usual it will be issued as Part 2 of the April PROCEEDINGS, and in the same wrapper as the regular number of that publication.

Committee of Maryland Section Reports Cooperation of Planning Groups

THE ENGINEERS Advisory Committee, sponsored by the Maryland Section, has made a report to the Citizens' Committee of Baltimore, covering all projects submitted under the Baltimore Plan for construction in the city and Metropolitan Area. This has resulted in a listing of projects according to sponsoring agency, cost, and urgency. The list is a part of the report of the committee made on October 8, 1943.

Briefly, this report consists of a list of construction and maintenance projects or items, proposed for a 3-year postwar period, totaling in the aggregate an estimated cost of approximately 94 millions, together with comments and recommendations. Due consideration has been given to the various factors affecting the program recommended, such as availability of funds, personnel, sites, the economic need, and the effect upon employment of component items. No "made work" has been recommended. Only those projects such as utilities, roads, bridges, and buildings which are deemed necessary within a reasonable period are listed. Each item of this program was considered in its relation to the whole, in order that the greatest utility and economy may be achieved.

along with employment in construction work of a wide range of skills. In order to distribute opportunity for employment during abnormal times, the list of projects includes not only heavy construction but repairs, maintenance, research, mapping—a program balanced, as to distribution of classes of employment, as perfectly as practicable.

Projects are arranged in the order of priority which appears at this time to be most feasible, based on the utility of the project and its usefulness in affording employment. Projects that cannot be constructed within a reasonable period of time, say three years, have been omitted entirely. Following each group list are notes as to present status of design and of sites, availability of funds, or of personnel for preparation of plans and specifications, and such other data as may be useful in reviewing this report. Specific recommendations are made as to each group and also as to the entire program.

The report recognizes the difficulties now being encountered by public agencies in maintaining sufficient personnel to carry on current maintenance and operation. It is quite impossible for them at this time to augment their staffs to the extent necessary to prepare plans and specifications for large-scale design and construction work. With few exceptions, it will be necessary to employ consulting engineers to assist in the work.

It was therefore recommended that the state and municipal authorities concerned be urged to provide, at once, under emergency legislation or otherwise, sufficient funds for the employment of engineers and architects, to prepare plans and specifications or to assist the public agencies in such preparation, covering the items or projects listed, and to acquire sites or rights of way so that the construction program can be started, if necessary or desirable, by April 1, 1944, and continued without interruptions.

Many suggestions have already been carried out and others are in progress. City and state authorities are quite active in coordinating plans for major highway projects, and it is hoped that complete agreement on joint plans will soon be reached.

Oregon Section Outlines Planning Procedure for Communities

A PLAN of procedure for communities as they face postwar needs has been formulated by a special committee of the Oregon Section. The report, which has been endorsed by the Oregon Technical Council, has been circulated widely throughout the state. The plan of work to be undertaken by each community or agency has been outlined as follows:

1. Organize a small but effective committee of interested and qualified persons.
2. List all projects that have been suggested or can be thought of.
3. Critically examine the foregoing list and eliminate the following:
   - (a) Projects that should properly be sponsored by some other agency.
   - (b) Projects that are not actually needed.
   - (c) Projects that are obviously beyond the means of the community.
   - (d) Projects that are for work relief only.
   - (e) Projects that are highly controversial and are likely to be delayed.
4. Roughly estimate the total cost of each project and the cost of preparing necessary plans and specifications.
5. Determine the method of financing each project.
6. Determine the legal steps necessary to permit accomplishment of each project.
7. Review the list of projects and eliminate any remaining that now appear impossible or unlikely of accomplishment.
8. List the remaining projects in the order that they should be undertaken.
9. Provide money to make any necessary engineering investigations and prepare plans and specifications for those projects where this is necessary. Have this work done.
10. Review and revise the cost estimates for each project in the light of more detailed information and engineering analysis.
11. Accomplish necessary legal steps to clear projects.
12. Complete financing.
13. Obtain right of way where this is necessary.
14. Build in an orderly way and in accordance with good engineering practices.

Long-Time Members

"THERE IS no friend like an old friend," runs a well-kn saying. Time is certainly a great tester of all the relationship life. Probably for this reason people like to celebrate anni saries and jubilees. While no particular celebration is indica any time is a good time to note the oldest members of the Soci that is, the oldest in terms of membership. The list change course, and the one here presented differs considerably from which appeared in CIVIL ENGINEERING a few years ago. A trarily, the present tabulation has been closed with those joined in 1890. These men have all been members continuo for over 53 years. But they are mere youngsters as compared the oldest member, C. Frank Allen, who has just celebrated sixty-sixth anniversary. The list, in order, covering these years, is as follows:

1878
- Feb. Allen, C. Frank

1882
- Sept. Thackray, George E.

1885
- Jan. Flad, Edward

1886
- Jan. Kittredge, George W.
- Apr. Barlow, John Q.
- Tratman, Edward E. R.
- Sept. Waddell, Montgomery

1887
- Feb. Purdy, Corydon T.
- Mar. Tuttle, Arthur S.
- Darwin, Harry G.
- Apr. Andrews, Horace
- May Hudson, John R.
- Sept. Bell, Gilbert J.
- Wada, Yoshichika

1888
- Jan. Carroll, Eugene
- Feb. Dennis, William F.
- Mar. Landor, Edward J.
- Apr. Clark, William G.
- May Tibbals, George A.
- Tibbals, Samuel G.
- Tompson, George M.

1888
- July Fisher, Edwin A.
- McCulloh, Walter
- Sept. Pratt, Mason D.
- Oct. Thomson, T. Kennard
- Nov. Bassett, Carroll P.

1889
- Jan. Pearl, James W.
- Feb. French, James B.
- Todd, Frank H.
- Mar. Whittemore, Walter F.
- June Pierson, George S.
- July Buck, Waldo E.
- Miller, Spencer
- Dec. Harwi, Solomon J.
- Keith, Herbert C.

1890
- Jan. Miller, Rudolph P.
- Feb. Connor, Edward H.
- Mar. Ross, Elmer W.
- May Staniford, Charles W.
- July Moses, John C.
- Sept. Quimby, Henry H.
- Triest, W. Gustav
- Oct. Cummings, Robert A.
- Stanford, Homer R.
- Nov. Jacoby, Henry S.
- Treadwell, Lee
- Dec. Davis, Chandler

One might easily conclude that these men are all beyond t years of activity and are enjoying a well-deserved rest. But t contrary is true in many cases. Many of them are not only acti but are putting in the full complement of hours every day. At le eight attended the Society's most recent Annual Meeting—pro ably the actual number was greater.

A realization of what these men have done, and what their a sociations have meant to the Society, will be an inspiration younger members.

Progress of Registration

IN ITS annual report to the Board of Direction the Committee Registration of Engineers notes that registration is now univer throughout the United States. During the year the State North Dakota adopted an engineering registration law. T leaves only Montana and New Hampshire lacking laws to regula the practice of professional engineering. In New Hampshire movement is now under way to promote adoption of a registratio law, the enactment to be based on the Society's Model Law.

News of Local Sections

Scheduled Meetings

Central Illinois Section—Lecture meeting at the Abe Lincoln Hotel on April 4, at 8 p.m.

Cincinnati Section—Annual meeting at the Herman Schneider Foundation on April 22, at 8 p.m.

Dayton Section—Luncheon meeting at the Engineers' Club on April 17, at 12:15 p.m.

Florida Section—Luncheon meeting at the McFadden-Deauville Hotel on April 28 (during the meeting of the Florida Engineering Society at Miami Beach on April 27, 28, and 29).

Maryland Section—Dinner meeting at the Engineers' Club on April 11, at 6 p.m.

Metropolitan Section—Technical meeting in the Engineering Societies Building on April 19, at 8 p.m.

Miami Section—Dinner meeting at the Royal Center Restaurant on April 6, at 7 p.m.

Mid-South Section—Spring meeting at the Arkansas Highway Commission Club on April 28—one-day meeting.

Northeastern Section—Dinner meeting at the Engineers' Club on April 20, at 6 p.m. (Joint meeting with Boston Society of Civil Engineers).

Northwestern Section—Dinner meeting at the Campus Club on April 3, at 6:30 p.m.

Philadelphia Section—Meeting at the Engineers' Club on April 11, at 7:30 p.m.

San Diego Section—Dinner meeting at the U.S. Grant Hotel on April 27, at 6:30 p.m.

Seattle Section—Dinner meeting at the Faculty Club on April 24, at 6:30 p.m.

Tennessee Valley Section—Dinner meeting of the Knoxville Sub-Section at the S & W Cafeteria on April 11, at 5:45 p.m.

Texas Section—Luncheon meeting of the Dallas Branch at the Adolphus Hotel on May 1, at 12:15 p.m. (luncheon meetings of the Dallas Branch are held the first Monday of each month at the Y.M.C.A. at 12:15 p.m.); luncheon meeting of the Fort Worth Branch at the Blackstone Hotel on April 10, at 12:15 p.m.; technical meeting of the Houston Branch at the Houston Engineers' Club on April 4, at 8 p.m.

Sacramento Section—Regular luncheon meetings at the Elks Club every Tuesday at 12 m.

San Francisco Section—Regular bi-monthly dinner meeting at the San Francisco Engineers' Club on April 18, at 5:30 p.m.

Tri-City Section—Dinner meeting at the Mississippi Hotel on April 6, at 6:30 p.m.

Wisconsin Section—Dinner meeting at "Smith's Fish Shanty" on April 28.

Recent Activities

Buffalo Section

The speaker at the February luncheon meeting was Lt. Col. N. Riebe, U.S. District Engineer at Buffalo. Colonel Riebe gave an illustrated lecture on his experiences in charge of military construction in the Panama Canal zone. The list of guests included Col. William Kelly, Honorary Member of the Society, and Earl L. Peterson, former member of the Section, who has been engaged on a construction project in Alabama.

Central Ohio Section

On February 17, D. H. Harker addressed the Section upon problems of ground-water shortage in various sections of the state. Mr. Harker is chief of staff of the Ohio Water Supply Board. During the business meeting preceding the technical program, the subject of collective bargaining was discussed.

Cincinnati Section

The Cincinnati Section was one of the participating groups in the ninth annual joint meeting of the Technical and Scientific Societies Council, which took place on March 2. There was an attendance of 1,300 to hear J. L. Collyer, president of the B. F. Goodrich Company, discuss "America's Rubber Outlook." Mr. Collyer was assisted by Waldo L. Semon and Arthur W. Carpenter, who gave an actual demonstration of the making of synthetic rubber.

Cleveland Section

"Bridge Building, Past and Present" was the subject of discussion at the February meeting of the Section, the principal speaker being Charles F. Goodrich. Dr. Goodrich, who is chief engineer of the American Bridge Company at Pittsburgh, Pa., illustrated his talk with slides. Bridge building during the Dark Ages, he pointed out, was in the hands of the Bridge Building Brotherhood. And many of the beautiful stone-arch bridges, built by these monks, were still in existence at the beginning of the present war.

Colorado Section

The U.S. Bureau of Reclamation was in charge of the technical program at the February 14 meeting of the Colorado Section. S. O. Harper, chief engineer of the Bureau, acted as master of ceremonies and introduced the speakers—E. B. Debler, director of the Bureau's Branch of Project Planning, and Douglas McHenry and John Stanley, engineers for the Bureau. Mr. Debler discussed the reclamation possibilities in the West after the war is over. He was followed by Mr. McHenry, who described, by the use of slides, the new triaxial machine for testing concrete that is being installed in the Bureau's concrete laboratory. The machine will be capable of developing a pressure of 125,000 lb per sq in. on a 6 by 12-in. cylindrical specimen. Finally, Mr. Stanley showed a reel of motion pictures on density currents, through the courtesy of the California Institute of Technology.

District of Columbia Section

Members turned out in force for the January 28th meeting, at which the speakers were Waldo G. Bowman and Harold M. Richardson, editors of *Engineering News-Record*. Both described their experiences as war correspondents in the various theaters of war—from Africa and the Mediterranean area to Alaska and the Aleutians. The February meeting, which was held under the auspices of the Local Section's Committee on Society Affairs, was devoted to a discussion of the Committee on Employment Conditions.

Iowa Section

At the February meeting of the Iowa Section, announcement was made of the Section's award of Junior membership in the Society to two Student Chapter members. The recipients are Delmar Bloem, of Iowa State College, and Gerald B. Cox, of the State University of Iowa. The latter spoke briefly, as did George Fellows, president of the Student Chapter at Iowa State College. Mr. Bloem, who graduated in August 1943, was unable to be present. Various committee reports were then discussed, and Messrs. Dawson, Dodds, and Stewart gave a report on the Annual Meeting in New York.

Los Angeles Section

The technical program for the February meeting of the Section consisted of a talk by John M. Server, Jr., and the showing of colored motion pictures of the construction of the Colorado–Big Thompson diversion tunnel. Mr. Server, who is editor of *Western Construction News*, discussed the engineering plans of the federal government as they affect the Western states. The other speakers were Vice-President Franklin Thomas, who gave a résumé of the Annual Meeting of the Society, and Director A. M. Rawn, who discussed recent developments of the Committee on Employment Conditions.

Maryland Section

A symposium on postwar planning and construction was the feature of the February meeting of the Maryland Section. Scheduled speakers were Paul L. Holland, president of the Section; G. Donald Kennedy, chairman of the Society's Committee on Postwar Construction; and B. Howell Griswold, Jr., chairman of the Maryland division of the National Committee on Economic Development. In the animated discussion that followed from the floor E. B. Whitman, Past-President of the Society, was called upon to describe the postwar plans of the state of Maryland, while Nathan L. Smith outlined the projects that the city is contemplating. Mr.

Smith is chief engineer of Baltimore. Other planning authorities who took part in the discussion were I. A. Pasarew, J. W. Steele, and Bancroft Hill.

Metropolitan Section

At the February 16th meeting of the Section E. L. Thayer presented a paper on the "Development of Modern Commercial Explosives." Mr. Thayer, who is in the Technical Service Section of E. I. du Pont de Nemours and Company, pointed out that modern civilization, with its tremendous problems of construction and transportation, would be seriously handicapped without the convenient, readily available energy of modern commercial explosives. The story of the development of these materials is an interesting example of modern chemical research.

North Carolina Section

The winter meeting of the North Carolina Section—held in Raleigh on the morning of January 29—took the form of a joint session with the North Carolina Society of Engineers. Papers had been prepared by Charles Ross, chairman of the North Carolina State Highway Commission, whose subject was "The Coordination of Municipal and State Highway Programs," and W. H. Weatherspoon, vice-president of the Carolina Power and Light Company, whose topic was "Postwar Planning in the Electrical Industry." However, illness kept both authors from attending, so their papers were read by W. Vance Baise and Dan Stewart. The next speaker was Charles W. Okey, principal civil engineer for the Tennessee Valley Authority, who discussed "Employment Conditions for Professional Engineers." A general discussion of Mr. Okey's topic, led by T. S. Johnson, concluded the technical program.

Northwestern Section

A special meeting of the Northwestern Section was held, in cooperation with other engineering organizations of the Northwest, in St. Paul on January 28. The guest of honor and speaker was Col. James L. Walsh, whose subject was "Logistics, the Key to Quick Victory." Colonel Walsh is director of the Army Ordnance Association. A talk on the contribution of chemical engineering to civil engineering comprised the technical program at the February meeting of the Section. This was given by Charles A. Mann, professor of chemical engineering at the University of Minnesota.

Oregon Section

"War and Peace-Time Aerial Mapping" was the subject of discussion on February 10, the principal speaker being Lt. Col. R. L. Moore. Colonel Moore, who is commanding officer of the 29th Battalion Headquarters at Portland, was assisted by Captains Maxon and O'Rourke. During the business session J. C. Stevens presented the report of the Committee on Postwar Planning.

Philadelphia Section

On February 19, members of the Philadelphia Section and their lady guests enjoyed their nineteenth annual social meeting. Following the custom inaugurated last year, the meeting was dedicated to the Service Men of the Section. As usual, between courses and after dessert, all joined in group singing, and later in the evening there was further social diversion in the form of a magician's show and program dancing. The technical program consisted of talks by Ensign Catherine Lucard, of the U.S. Naval Reserve, and Captain Critchlow, of the U.S. Army. Ensign Lucard spoke briefly on the work of the Waves, while Captain Critchlow discussed his experiences with the Army in Alaska during the past two years. The latter is the son of Howard T. Critchlow, president of the Section. Following the presentation of several films—shown through the courtesy of the U.S. Navy and the B. F. Goodrich Tire and Rubber Company—the group adjourned for social dancing and the usual Paul Jones. Lyle L. Jenne was master of ceremonies.

Pittsburgh Section

At the annual meeting of the Pittsburgh Section, which took place on February 2, Society Director C. F. Goodrich gave a résumé of the Annual Meeting. Certificates of life membership in the Society were then presented to Louis P. Blum and C. L. Wooldridge. Another new life member, Harry W. Claybaugh, was unable to be present and receive his certificate in person. The remainder of the evening was devoted to discussion of the Board of Direction's recent action on the report of the Committee on Employment Conditions.

Rochester Section

The technique of aerial photography and the utilization of aerial photographs for mapping were described by Harry W. Eustance at the February meeting of the Section. Mr. Eustance, who is a engineer for the Eastman Kodak Company in Rochester, pointed out that mapping from aerial photography means charting sections of the globe, where transits, levels, or plane tables have not yet been seen. The war has made the precise aerial camera the new surveying instrument. For instance, when it has been necessary to chart routes for the Allied Military Transport over unmapped areas in all parts of the world, these routes have been mapped by air.

Sacramento Section

A motion picture of the construction of the Rainbow Arch Bridge over Niagara Gorge was presented February 1 by Milo S. Farwell of the Bethlehem Steel Company. The Section found the scenes so realistic that it held its breath while riggers walked the high iron. On February 15, I. C. Steele, of the San Francisco Section, described by means of slides the Pit No. 5 Project of the Pacific Gas and Electric Company, particularly the grouting of fractured porous lava below the solid foundation rock of the diversion dam and the lining of an 8-mile penstock tunnel. Capt. Gordon Long, of the Corps of Engineers, completed the month's program with an account of stabilization of a pulverized sandstone base at Concord Airport with an admixture of 0.8 sack of cement per cu yard.

San Francisco Section

The technical program at the regular bi-monthly meeting of the Section, held on February 15, consisted of an address by A. M. Rawn, Director from District 11. Mr. Rawn discussed the activities of the Society's Committee on Employment Conditions, and a round-table on the subject of collective bargaining followed his talk.

At the meeting of the Junior Forum, which took place on January 27, addresses were given by Arthur Reinhardt and Robert Richardson. Mr. Reinhardt, who is engineering aide in the Pasadena Sewage Treatment Plant, discussed the activities of the State Bureau of Sanitary Engineering, while "Stabilization of Highway Foundations" was Mr. Richardson's subject. The latter is assistant highway engineer for the California State Division of Highways. The topic for discussion was "Should the Civil Engineering Registration Law Be Changed."

Tacoma Section

The January meeting of the Section took the form of a dinner dance, at which the ladies of the Section were guests. Miss Martha Sandin, of the College of Puget Sound, entertained during the turkey dinner with a group of Scandinavian folk songs and accordion selections. Later the group assembled in the lounge for community singing, led by Mr. and Mrs. Fred M. Veatch. Mrs. Betty Allen and Mr. Veatch then entertained with a series of vocal duets, after which the group adjourned for dancing and bridge.

Toledo Section

An illustrated talk on the subject of asphalt comprised the technical program at the February 16th meeting of the Section. This was given by A. H. Hinkle, district engineer for the Asphalt Institute at Cincinnati. During the business session collective bargaining was discussed. Short reports were made by W. P. Sandbacher, Robert Brown, Carleton Finkbeiner, and Harvey P. Jones, who had attended meetings at which the subject of collective bargaining was discussed.

Utah Section

A joint meeting of the Utah Section and the local chapter of the Society of American Military Engineers was held on February. Following a turkey dinner, A. E. Perlman, chief engineer of the Denver and Rio Grande Western Railroad Company, described a recent fire in one of the tunnels on the line and discussed the engineering problems involved in stopping the fire and clearing out and relining the tunnel and restoring it to use. The timber lining was completely burned out, and the fire was so intense in spots that the granite rock actually melted. The other speakers were two young men—Captain Brown and Lieutenant Shields—in the Army Air Force, who have returned from duty in the Pacific and are temporarily hospitalized at Brigham City. Captain Brown had completed 72 bombing missions before he was forced to make an emergency landing.

ITEMS OF INTEREST

About Engineers and Engineering

ig-Inch Pipe Lines Represent Immense Pumping Job

MUCH has been spoken and written in the last few months about the new 24-in. pipe line. In fact, the "Big Inch" has become another American by-word of construction accomplishment. And rightly so, for under wartime conditions of engineering and construction, this project, the greatest in the realm of petroleum transportation, has been carried to rapid completion as a vital factor in the war effort.

From the viewpoint of power application, the Big Inch is a 1,400-mile underground conduit, 24 in. in diameter for 1,254 miles of its length, from Longview, Tex., to Phoenixville, Pa., where it divides into two 20-in. lines, one branch leading to the Philadelphia area, totaling some 40 pipe miles, the other extending about 90 miles to the New York area.

The route encounters all varieties of terrain, ranging from Mississippi bottomland to the ridges of the Alleghenies. Between an elevation of 313 ft at Longview and seaboard at its eastern termini, its highest point is the 2,920-ft Laurel Hill crossing, in Pennsylvania.

When operating at ultimate capacity, the line will carry a continuous 1,400-mile column of oil from Longview to Linden, N.J.—more than four million barrels of oil—weighing 600,000 tons, at a speed of about $4^1/_4$ miles per hour. To accomplish this requires a total propelling force equivalent to about 4,250 tons. This force and rate of motion represent the continuous expenditure of nearly 100,000 hp—by that measure one of man's greatest pumping jobs.

This task is performed by electrically driven centrifugal pumps. The aggregate installed electric-motor capacity, applied to main-line pumping, is approximately 125,000 hp. This capacity is in 83 units of 1,500 hp each, in essentially 28 stations (3 units per station), at intervals averaging about 50 miles. Additional spare and auxiliary units bring the total installed horsepower to about 130,000.

And now the Big Inch has a rival, the new 20-in. refined-products line under completion from Beaumont, Tex., to the Philadelphia and New York areas. This is called "Little Big Inch" because it is a trifle smaller in the waist. It is 150 miles longer, and it really does a bigger job than Big Inch, for its capacity of 235,000 bbl per day of refined products will represent the equivalent of some 370,000 bbl of crude oil.

Little Big Inch, drawing products from ten refineries in the Baytown and Beaumont areas, runs 350 miles to Little Rock, Ark., where it joins the right of way of the 24-in. line and follows it from there on to the East. Beginning at Little Rock, the stations on the 20-in. line are at the same sites as those on the 24-in. line. Thus substantial savings are effected in costs of right of way, station sites, power procurement, energy costs, operating labor, and operating maintenance.

(*This item has been extracted from a paper presented by Merritt A. Hyde, Petroleum Industry Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., before a meeting of the Power Group, American Institute of Electrical Engineers.*)

Navy Commissions for Hydrographic Officers

THE NAVY is interested in commissioning additional men as Hydrographic Officers. These men will be assigned to surveying duties on board a fleet survey vessel or as Cartographic Officers on an auxiliary vessel or with amphibious units.

A college degree in civil engineering and two years of experience in one or more of the following fields is desired: hydrographic or geodetic surveying; land and topographic surveying or mapping; city surveys or mapping, preferably with triangulation experience; construction surveys; plotting on maps or charts or working up field notes of survey parties along any of the above lines. In the absence of a degree, applicants should have two years in an accredited college of engineering, plus four years of practical experience in one or more of the fields listed, in addition to some transit or theodolite experience. A knowledge of piloting and navigation would be a valuable additional qualification.

The age bracket is 25 to 40. Applications should be made at the Office of Naval Officer Procurement, 33 Pine Street, New York 5, N.Y., or to other procurement offices in principal cities.

Concrete Curing by Membranous Compounds

RECENTLY a meeting was called in Chicago for organizing manufacturers of membranous compounds for curing concrete. The stated purpose of the new organization, called the Concrete Curing Manufacturing Association, is unification and betterment of the concrete curing industry. The primary aim is clarification of testing methods, adoption of standard specifications, and establishment of uniform application methods.

The new association presented a communication to Committee 617 of the American Concrete Institute, suggesting the inclusion of membranous curing as an alternative method in the specification now under consideration and recommended that the standard test for evaluating membranous cures be A.S.T.M. standard C-155-40T, with certain minor modifications.

The modifications recommended are first that minimum net moisture retention be 95% as against the existing 85%, and that net moisture loss be defined as the loss occurring after the application of the compound, with allowance for loss of volatile matter, and second, that the maximum allowable coverage for any compound be set at 200 sq ft per gal. Both of these modifications are said to conform generally to existing practice in the industry.

It was also recommended that the specification be standardized with that of the Highway Research Board. The chairman of the new organization is Gloster P. Hevenor, M. Am. Soc. C.E.

Plans to Build 21,000 Miles of Highway in '44

SPURRED by the shipping shortage and the need of the United Nations for her raw materials, Brazil is pressing rail and highway construction programs to link the south and northeast sections of the country. Construction under way or projected will open undeveloped territory in the interior. It will provide highway transportation between Brazil's coastal cities, from the Uruguayan border south to the seaports on the northeastern coast. The connecting highways and rail lines now being built in the seaboard area will correct the tendency in the past for roads and railways to extend fanwise into the hinterland of coastal cities in separate networks.

The most important of the connecting roads is the "Getulio Vargas" Highway, which will link the southernmost state, that of Rio Grande do Sul, and the state of Para, in the north, and will be approximately 3,700 miles in length. The immediate objective, however, is completion of the 3,300-mile route to Fortaleza, a seaport on the northeastern coast. The "Getulio Vargas" Highway is one of 27 new highways, and has a total length of some 21,000 miles, included in Brazil's 1944 road-building plan.

Brazil also is working toward a transcontinental rail connection from Santos and Rio de Janeiro on the Atlantic coast to Arica, Chile, on the Pacific coast, via La Paz, Bolivia. A force of 2,500 workers has laid track nearly 250 miles west of the Brazilian border town of Corumba toward Santa Cruz, Bolivia. This rail construction, financed by a credit from the Brazilian Government, is expected to reach Santa Cruz, 125 miles distant, by the end of 1944.

Engineering Courses Offered for Returning Veterans

FOR the benefit of returning veterans, Rensselaer Polytechnic Institute has organized special courses in three fields of engineering and in chemistry. The course will run for sixteen months, or for two academic years under the accelerated program; and will prepare those taking them for attractive and profitable employment in the postwar adjustment period, and at the same time meet the needs of industry for trained personnel. Veterans will be qualified, for example, as engineering assistants and laboratory technicians, and for supervisory responsibilities greater than those usually entrusted to the vocational school graduate and less than those generally assumed by the graduate engineer.

The courses in civil engineering will include chemistry, elementary surveying, geodesy, mechanics, curves and earthwork, sanitary engineering, contracts and specifications, strength of materials, and highways and airports.

N. G. Neare's Column

Conducted by

R. ROBINSON ROWE, M. AM. SOC. C.E.

"YOU gentlemen of the Engineers Club will be interested in this telegram I received yesterday, but since it tells the secret length of the slippery ladder, I'm going to save it for awhile. I see Joe Kerr has a big drawing all rolled up. Is that your answer, Joe?"

"Right, Professor. This was one of your easier ones meant just for me. In these two drawings, Fig. 1 (*a*) and (*b*), I have let *a* be the distance from the foot of the ladder to the wall. In each I have computed the reactions at ends of the ladder in terms of *a*—for the two given loadings. Since the ladder was about to slip in each case, the two expressions for friction at foot of ladder must be equal, or

$$\frac{16a}{5} = \frac{144a}{25 + a}$$

Solving, $a = 20$ and the length of the ladder is $\sqrt{1{,}025} = 32.02$ ft."

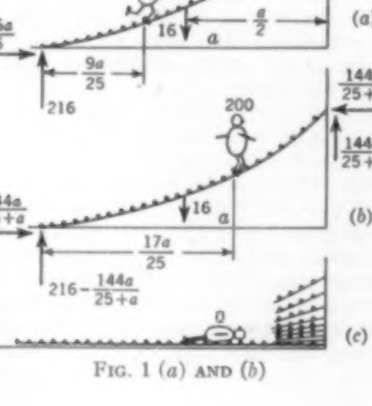


FIG. 1 (*a*) AND (*b*)

"In my humble opinion," suggested Cal Klater, "Joe's figure is nearer than his figuring. Instead of equating the two expressions for friction, he should have matched the coefficients of friction—the ratios of horizontal to vertical components of reactions at foot of ladder, thus:

$$\frac{\frac{16a}{5}}{216} = \frac{\frac{144a}{25 + a}}{216 - \frac{144a}{25 + a}}$$

which reduces to $\frac{2a}{135} = \frac{2a}{75 + a}$. So $a = 60$ and the ladder was 65 ft long. And in my not-so-humble opinion, the shortage of strategic materials doesn't justify ladders so unhell-for-stout!"

"And pity the 200-lb lad," cried Ken Bridgewater. "There's no stopping the ladder when it starts to slip. The first time was an easy jump; when the dumb lad tried again, he went up plump comma and came down plump period."

"Which explains this telegram," said the Professor. "It's from a chap named Jacob, and reads, 'That 65-ft 16-lb ladder is the one I dreamed about stop the plump lad just arrived stop he told me and the angels the ladder was made of a new alloy of magnesium and helium stop we sent him down to tell it to the marines end message Jacob.'

"You will be glad to hear that my foreign correspondent, Alenfer de l'Axe is covering operations of the Sea Bees on Eniwetok. He was astonished by the formality of the battalion parade ground with its four equal sides marked by pylons of coral rock. A magnificent palm was trimmed in place for the flagpole. When one company parades alone, it lines up exactly between the pole and Pylon *A*, two companies just reach from the pole to Pylon *B*, three from the pole to Pylon *C*, and when the whole battalion of four companies is in line, it connects the flagpole to the fourth Pylon *D*. If a company front is 100 ft, what is the size of the field?"

[*Cal Klaters this month, with many new faces, were: Prof. F. H. Constant, Richard Jenney, Isidore Knobbe (Jos. S. Lambie), J. W. Pickworth (our illustrator), Lloyd Turner, Max W. Strauss, Edward Soucek, Ole Sly Drool (L. C. Hollister), Leon Beskin, Count Harvey, Gerald R. Garrison, Prof. Robt. E. Tobin, K. V. Steinbrugge, X. Tracter (Benjamin Eisner), Claude W. West, F. V. Pohle, James R. Bole, and Arthur L. Elliott. Several Joe Kerrs agreed on the wrong answer.*]

NEWS OF ENGINEERS

Personal Items About Society Members

ROBERT O. R. MARTIN, associate hydraulic engineer for the U.S. Geological Survey, has been transferred from the water resources branch in St. Louis, Mo., to the district office in the hydraulics laboratory of the Iowa Institute of Hydraulic Research at Iowa City, Iowa. Another member, PAUL C. BENEDICT, has been temporarily detailed from the Iowa C district office for a special assignment the headquarters' office in Washing D.C. Mr. Benedict is also an associ hydraulic engineer.

ENOCH R. NEEDLES has been promo from the rank of lieutenant colonel in Corps of Engineers, U.S. Army, to that colonel. He is chief of the Redistributi and Salvage Branch of the Supply Di sion, Military Supply, in Washingt D.C.

IVAN C. CRAWFORD was the recipi of the honorary degree of doctor of scie from the University of Colorado, his al mater, on February 11. Dean Cra ford, who is head of the college of engine ing at the University of Michigan, h recently been serving in Washingt D.C., as consultant to the Training Di sion of the Bureau of Naval Person and also as consultant on training pro lems for the Ordnance Department.

C. FRANK JOHNSON'S engagement chief engineer of the Commissioners Sewerage of Louisville, Ky., has be terminated by the completion of the wo and the dissolution of the Commissio Mr. Johnson has joined the staff of Me calf and Eddy, Boston (Mass.) co sultants, for whom his first assignment a study of the sewerage problems Honolulu, T.H.

CHARLES G. RICHARDSON was recentl elected a vice-president of the Builder Providence, Inc., division of Builde Iron Foundry at Providence, R.I. M Richardson has been connected with th organization for over forty years, and late years has been manager of its Ventu Department at Providence.

ELLWOOD H. ALDRICH announces tha as of March 1, he will continue the co sulting engineering practice of Newso and Aldrich as Ellwood H. Aldrich, co sulting engineer, with offices at 500 Fift Avenue, New York City, and the Goodwi Building in Williamsburg, Va. Hi partner, REEVES NEWSOM, has left th organization in order to become villa manager of Scarsdale, N.Y.

THORNDIKE SAVILLE, dean of the co lege of engineering at New York Unive sity, received the honorary degree doctor of engineering from Clarkson Co lege of Technology at the fifty-fourt commencement exercises held in Potsdam N.Y., on February 13.

GEORGE E. STEWART was recentl promoted from the rank of major in th Corps of Engineers, U.S. Army, to th of lieutenant colonel. He is commandin an Aviation Engineering Battalion.

FRANCIS W. STAFFORD has moved fro Port Arthur, Tex., to Dallas Tex., whe he has his office in the Allen Building He is representing Prack and Prack Architects, and the Chester Engineers.

JAMES P. EXUM has been appointe chief bridge engineer for the Texas Stat Highway Department, succeeding th late GEORGE G. WICKLINE. Until lately Mr. Exum has been senior designing engi neer for the Department.

FRANK SMITH has been promoted fro the rank of captain in the Corps of Engi

ers, U.S. Army, to that of major. He is tioned at Camp Maxey, Tex. Prior being called to active duty Major ith was professor of civil engineering North Texas Agricultural College at lington, Tex.

WALTER F. KUEHNE, formerly contract- manager for the Bethlehem Steel Comny at Houston, Tex., now has the rank lieutenant in the U.S. Navy. He is tioned at Atlanta, Ga., where he is ief expediter for the Southeastern area.

WILLIAM MARTIN JOHNSON was rently promoted from the rank of captain in e Sanitary Corps of the U.S. Army to at of major. He is chief engineer of e Mexican Field Party, Division of ealth and Sanitation, Institute of Inter-merican Affairs. Another member in e Sanitary Corps who has also been omoted is S. LADD DAVIES from the nk of first lieutenant to that of captain. he latter is sanitary engineer with the anama Field Party of the Division of ealth and Sanitation.

LEWIS A. HOWLAND has retired as vice-resident and general manager of the ueens Borough Gas and Electric Comany at Far Rockaway, N.Y., after thirty-ve years of continuous service with the rganization. He had been vice-presient and general manager since 1927, and director since 1933.

KENNETH C. REYNOLDS has been apointed head of the department of civil ngineering at Cooper Union with the nk of full professor, succeeding PROF. DWARD S. SHEIRY, who has resigned. Dr. Reynolds, who is widely known for is studies in hydraulic engineering, is ow on leave of absence from Massahusetts Institute of Technology—in harge of a special investigation of waves or the Bureau of Ships under the Woods Hole Oceanographic Institution.

I. C. STEELE, formerly chief of the Division of Civil Engineering of the acific Gas and Electric Company, with eadquarters in San Francisco, has been ppointed chief engineer of the company. WALTER DREYER, previously assistant hief of the Division of Civil Engineering f the company, will succeed Mr. Steele s chief of the Division.

WILLIAM J. COX, highway commissioner f Connecticut since 1938, was elected resident of the Association of Highway fficials of the North Atlantic States at e annual meeting of the association, hich took place in New York on February 17 and 18.

A. M. WESTENHOFF has been made ssistant engineer of structures for the New York Central Railroad, Lines West, ith headquarters at Cleveland, Ohio. e was formerly assistant engineer of ridges for the railroad in Chicago.

COLLINGWOOD BRUCE BROWN, of Monreal, Canada, is retiring as consulting ngineer of the Canadian National Railay after thirty years' service with the ne and its predecessor, the Canadian overnment Railway.

EDWARD ARTHUR BELL has resigned as orough engineer of Essex Fells, N.J., in rder to accept a commission as lieutenant (jg) in the U.S. Naval Reserve. He is temporarily stationed at Camp Peary, Virginia.

GEORGE H. HUTCHINSON was recently honored at a farewell dinner in Pittsburgh, upon his retirement as assistant chief engineer of the Pittsburgh and Ohio Valley Railway. Mr. Hutchinson has been in engineering work over sixty years.

EARL M. KELLY, commander, Civil Engineering Corps, U.S. Naval Reserve, following a year of advance base construction in the Aleutian Islands, is now in the South Pacific as officer-in-charge of the Twelfth Naval Construction District.

SAMUEL F. NEWKIRK, JR., engineer and superintendent of the Board of Water Commissioners of Elizabeth, N.J., has been elected president of the American Water Works Association. Mr. Newkirk served during the past year as vice-president of the Association, and is a holder of the Diven Medal and the Fuller Award, two of its citations.

OTTO K. JELINEK has been promoted from the position of traffic engineer for the Chicago (Ill.) Park District to that of planning engineer. He was recently on leave of absence as Director of Techniques in the Office of Civilian Defense.

PHILIP HARRINGTON, commissioner of subways and superhighways for the city of Chicago, was awarded an honorary degree of doctor of engineering by Illinois Institute of Technology at its fiftieth anniversary convocation on February 21. The citation given him read in part, "For preeminent contributions . . . as the engineer and administrator who directed the design and construction of the city's subways and whose plan for a superhighway system will shorten the period needed for its accomplishment." The celebration was occasioned by the fact that Armour Institute of Technology, which merged with Lewis Institute in 1940 to form the Illinois Institute of Technology, admitted its first students fifty years ago this past fall.

I. W. MENDELSOHN, major, Corps of Engineers, U.S. Army, is now on active duty overseas as a military government specialist. He was formerly first post engineer at the Fort Worth (Tex.) Quartermaster Depot.

WILLIAM R. HARDY has been promoted from the rank of first lieutenant in the Sanitary Corps of the U.S. Army to that of captain. He is stationed in New Guinea, where he is engaged on malaria-control work.

MILTON E. SCHMIDT, hydraulic engineer in the U. S. Engineer Office at Denison, Tex., has gone to Washington, D.C., for temporary duty in the office of the Chief of Engineers.

W. H. MEAD, formerly chief engineer and general superintendent of the Salt Flat Water Company at Luling, Tex., is now supervising engineer on the construction of the war emergency pipe line from Texas to New Jersey, being engaged at present on the construction of the Baytown (Tex.) pump station. When the project is completed, Mr. Mead will be district foreman of the Baytown district and of the operation of the pipe line.

ALAN LEE SLATON, commander, Civil Engineering Corps, U.S. Naval Reserve, is officer-in-charge of a Seabees battalion in the South Pacific.

SAMUEL L. FULLER has been elected president of the board of directors of the John F. Casey Company, Pittsburgh, Pa., to fill the vacancy caused by the death of C. E. Lott. Mr. Fuller has been associated with the company for over thirty years—for the past fifteen years as vice-president in charge of engineering and construction.

BENJAMIN P. ROBINSON, formerly construction safety engineer for the Liberty Mutual Insurance Company in New York, is now an ensign in the Construction Battalions of the U.S. Navy. He is temporarily stationed at Camp Peary, Virginia.

PAUL W. BAKER is now project superintendent for Midland Constructors, Inc., at Camden, N.J. Until recently he was designer and construction engineer for the Harza Engineering Company in Chicago.

ROBERT F. HOFFMAN was recently promoted from the rank of captain in the U.S. Army to that of major. He was formerly in the Air Corps, but has recently been transferred to the Corps of Engineers. He is now stationed at St. Petersburg, Fla.

DECEASED

PAUL LEONARD BEAN (M. '24) of Auburn, Me., died on January 29, 1944. Mr. Bean, who was 62, had been agent and engineer for the Union Water Power Company and the Androscoggin Reservoir Company at Lewiston, Me., since 1924. Earlier in his career (1906 to 1915) he taught at the University of Maine—for part of this period in the capacity of associate professor of civil engineering. He was chief engineer for the State of Maine Public Utilities Commission from 1915 to 1919, and was a member of the consulting firm of Sawyer and Bean from the latter year to 1924.

RALPH NORMAN BEGIEN (M. '17) retired railroad executive and former Director of the Society, died at his home in Richmond, Va., on February 27, 1944. He lacked a few days of being 69. Mr. Begien's first work was with the U.S. Nicaragua Canal Commission and the Isthmian Canal Commission, and on railroad construction in South America. From 1902 until his retirement in 1929 he was with the Chesapeake and Ohio Railroad—from 1923 on as vice-president. Coincidentally for part of this period, he was also vice-president of the Hocking Valley Railway Company. In 1923 and 1924 Mr. Begien served as Director of the Society.

WILLIAM HENRY BREITHAUPT (M. '87) retired consulting engineer of Kitchener, Ontario, Canada, died on January 26, 1944, at the age of 87. A pioneer civil engineer in the Kitchener district, Mr. Breithaupt for many years maintained a consulting practice there and in Toronto.

Earlier in his career he had been with the West Shore and Buffalo Railway; the Canadian Pacific Railway; and the Atchison, Topeka and Santa Fe Railway. He was one of the first proponents of a conservation scheme for the Grand River Valley.

THOMAS AMORY COFFIN (M. '99) of Westfield, N.J., died on January 21, 1944. He was 75. From 1902 to 1909 Mr. Coffin maintained an engineering and contracting practice in New York. He then became connected with the New York Edison Company, and from 1912 to 1924 was chief engineer for the Heine Boiler Company at Phoenixville, Pa. Later he was with the Philadelphia Department of City Transit, and the Reading Company in Philadelphia. His most recent assignment was with Day and Zimmerman, of Philadelphia, for whom he designed the power plant for the U.S. government project at Burlington, Iowa.

EDWARD BROWN DONOHUE (M. '40) died in New York City on February 9, 1944, at the age of 48. Mr. Donohue had been resident engineer and chief engineer for the Montana State Highway Commission, and chief engineer for the Montana Water Conservation Board. At one time, also, he was state engineer of Montana. More recently he was general manager for Pleasantville Constructors, Inc., on a government construction project in the Bahamas.

FRANK WILLARD HANNA (M. '13) of Webster City, Iowa, died there on January 26, 1944, at the age of 76. Once head of the Canadian Land and Improvement Company at Medicine Hat, Alberta, Mr. Hanna went to Oakland, Calif., in 1924, as hydraulic engineer for the East Bay Utilities District. Later he was made chief engineer and general manager. At various periods in his career Mr. Hanna was connected with the U.S. Bureau of Reclamation, and he was one of the designers of Pardee Dam on the Mokelumne River.

BENNETT KAY (Assoc. M. '16) of Cincinnati, Ohio, died in that city on February 14, 1944, at the age of 56. Beginning in 1910, Mr. Kay was for some years with the Indianapolis Union Railway Company. He then became engineer of buildings for the Illinois Central Railroad in Chicago, and later maintained an architectural and engineering practice in Indianapolis, Ind. His most recent connection was with the Federal Works Agency in Washington.

EUGENE CLARE MILLER (Jun. '35) of Redondo, Calif., was killed in the crash of an airliner near Memphis, Tenn., on February 10, 1944. Mr. Miller, who was 30, was chief estimator for the Consolidated Steel Corporation, of Wilmington (a suburb of Los Angeles), and was on a business trip for the company at the time of his death. A graduate of the California Institute of Technology, Mr. Miller had spent his entire career with the Consolidated Steel Corporation.

MARION DE KALB SMITH, JR. (Assoc. M. '11) civil engineer of Chestertown, Md., died on January 20, 1944. Mr. Smith, who was 64, spent much of his career with the Pennsylvania Railroad with which he became connected in 1901. He was engaged on various railroad construction and maintenance projects in Pennsylvania, New Jersey, and Maryland, and supervised the electrification of the West Jersey and Seashore Railroad, a subsidiary of the Pennsylvania Railroad.

WILLARD WILBERFORCE STONE (M. '23) civil engineer of Glen Cove, N.Y., died on February 11, 1944, at the age of 71. For several periods in his career Mr. Stone was with the New York State Highway Commission on the design and construction of highways. He had also been assistant engineer for the New York City Board of Water Supply (1906 to 1913), and senior highway engineer for the U.S. Bureau of Public Roads. Later he was resident engineer for Fuller and McClintock, sanitary engineers, in charge of the construction of various sewerage and water-supply projects.

CHARLES AUGUST THANHEISER (Assoc. M. '07) retired engineer of Houston, Tex., died suddenly at his home there on February 7, 1944. Mr. Thanheiser's early career was spent in railroad work—he had been with the Southern Pacific and the Missouri Pacific Railroad. Later he was consulting engineer for the Brier Hill Steel Company at Youngstown, Ohio, and for some years was president of the Southwestern Construction Company at Houston. In the latter capacity he built some of the most notable structures in Houston. Mr. Thanheiser retired in 1935.

ELTON DAVID WALKER (M. '00) professor emeritus of civil engineering at Pennsylvania State College, died at State College, Pa., on February 24, 1944. Professor Walker, who was 74, had been affiliated with the college since 19[illegible], serving as head of the department of civil engineering from 1907 until his retirement in 1939. Before joining the Penn State faculty, he taught at Union College and the Massachusetts Institute of Technology. During the first World War he served as a captain of Engineers in the U.S. Army, and later was made a colonel in the reserve.

EVERETT PINE WEATHERLY (M. '12) president of the List and Weatherly Construction Company, of Kansas City, Mo., died there on February 22, 1944, at the age of 66. From 1899 to 1911 Mr. Weatherly was construction engineer for the Chicago, Burlington and Quincy Railroad, and from 1911 to 1914 division engineer for the Kansas City Terminal Company. From the latter year on he was with the List and Weatherly Construction Company—since 1934 as president. Mr. Weatherly was president of the Associated General Constructors of Missouri.

JULIUS EDGAR WILLOUGHBY (M.'09) of Sarasota, Fla., died there on March 11, 1944. From 1913 until his retirement last year Mr. Willoughby had been with the Atlantic Coast Line Railroad, with headquarters at Wilmington, N.C. For most of this period he was chief engineer. Practically all his earlier career had been spent with the Louisville and Nashville Railroad, which he served in various capacities, and in 1912 he was chief engineer for the Caribbean Construction Company.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From February 10 to March 9, 1944, Inclusive

ADDITIONS TO MEMBERSHIP

ALBERT, GEORGE LELAND (Jun. '43), Apprentice Engr., Pan Am. Airways, Inc., King County Airport (Res., 4518 Seventeenth, N.E.), Seattle 5, Wash.

ALLEN, ROBERT ALFRIEND (Jun. '44), Structural Engr., Carbide & Carbon Chemicals Corp., South Charleston (Res., 1218 Highland St., St. Albans), W. Va.

ASMUS, LEWIS DURAND (M. '44), Maj., Corps of Engrs., U.S. Army, Colorado Springs, Colo.

BARTHOLOMEW, CHARLES KANE (Jun. '43), Ensign, U.S.N.R.; Box 75 A, R.F.D. 2, Huntington, N.Y.

BEARD, FRANK JOSEPH (M. '44), Civ. Engr., Kahoka, Mo.

BERRY, ROBERT WILLIAM (Jun. '44), Junior Stress Analyst, The Glenn L. Martin Co., Middle River (Res., 4809 Walther Blvd., Baltimore 14), Md.

BELLER, GORDON MELVIN (Jun. '43), Thermodynamicist, North Am. Aviation, Inc., Inglewood (Res., 103 South Edgemont, Los Angeles 4), Calif.

BERGER, HILDING ERNEST (Assoc. M. '43), Branch Mgr., Griffin Eng. Corp., 548 Indiana St., Hammond, Ind. (Res., 7130 South Cyril Parkway, Bedford Villa Apartments, Apt. 615, Chicago. Ill.)

BLOCK, HENRY DAVID (Jun. '44), Flight Test Engr., Goodyear Aircraft Corp., 1210 Massillon Rd. (Res., 177 Oakdale Ave.), Akron 3, Ohio.

BRENTON, WALTER (M. '44), Lt. Comdr., CEC, U.S.N.R., Naval Air Station, Floyd Bennett Field, Brooklyn, N.Y.

BROWN, FRANK EUGENE (Assoc. M. '44), Associate Materials Engr., The Panama Canal, Balboa, Canal Zone.

BUCHER, JAMES DOOLEY (Jun. '43), Ensign, U.S.N.R.; Oregon, Mo.

BURFORD, WILLIAM OWEN (Jun. '44), Junior Civ. Engr., TVA, Box 551, Fontana Dam, N.C.

CAMPBELL, LINDEN CARLYLE (Jun. '43), Draftsman, Fluor Corp., Ltd., 1012 Baltimore, Kansas City, Mo. (Res., 7525 Marty, Overland Park, Kans.)

CHANDLER, SYDNEY WILLIAM (Assoc. M. '44), Senior Civ. Engr., Corps of Engrs., Aberdeen Proving Grounds (Res., 2507 Queen Anne Rd., Baltimore 16), Md.

COLE, DALLAS ERVIE (Assoc. M. '44), Associate Engr., U.S. Engr. Dept., Box 5180, Metropolitan Station (Res., 4945 Highland View Ave.), Los Angeles, Calif.

COOPERRIDER, VERNE KEITH (Jun. '43), Junior Engr., Permanente Metals Corp., Shipyard 2, Richmond (Res., 2456 Hilgard Ave., Berkeley 4), Calif.

DIAMOND, IRVING MILTON (Jun. '44), With DeWitt Tool Co., 248 Central Ave., Newark (Res., 287 Conklin Ave., Hillside), N.J.

DINKER, JOHN DEWITT (Jun. '44), Instr., Civ. Eng., Univ. of Pittsburgh, 310 State Hall (Res., 803 South Negley Ave.), Pittsburgh, Pa.